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NEW ROTHSCHILD PALEONTOLOGICAL COLLECTION AT PARIS.

By the Paris Correspondent of SCIENTIFIC AMERICAN.

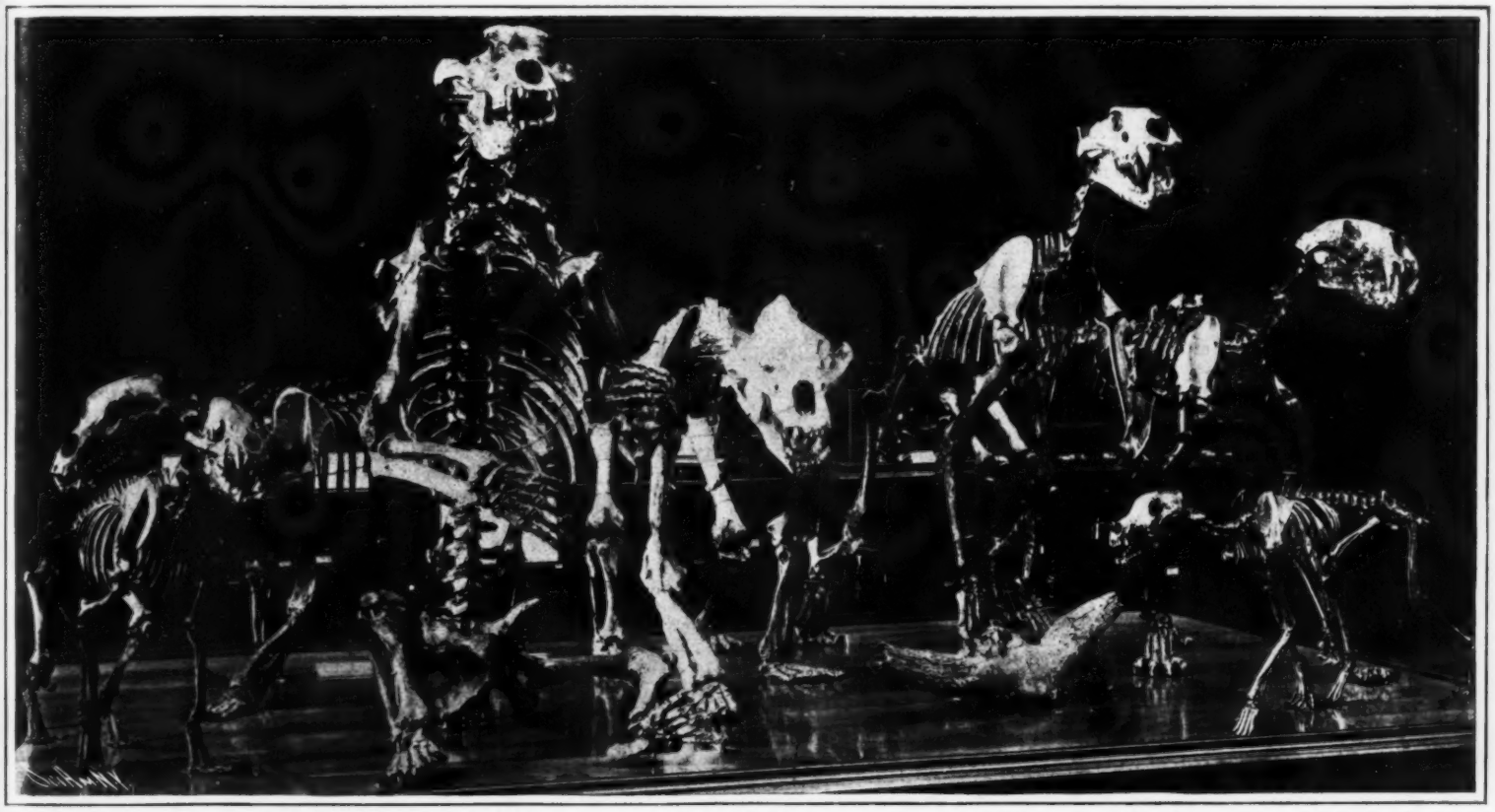
THE Paleontological Department of the Paris Museum of Natural History has recently mounted an important collection of Quaternary animals. The collection contains several species which represent the principal carnivorous animals of the period of the cave-dwellers. Before the present collection was mounted as a whole, the museum already possessed several skeletons which were almost complete. It was desired to acquire others and to form a characteristic collection of the carnivorous animals. Owing to the liberality of Baron Edmond de Rothschild, this project has now been carried out, and the Paris collection, which is contained in a large glass case, is no doubt the most complete in Europe.

Our illustration shows the group of seven species which have been mounted in life-like positions, under the direction of Prof. Marcel Boule, who is at the head of the Paleontological Department. We thus have the principal ferocious animals against which our prehistoric ancestors had to carry on the struggle for existence, and this makes the study of these specimens of more than ordinary interest. The cave lion was no doubt the greatest antagonist of Quaternary man, and the existing remains show that it was considerably larger than our modern lions. On the contrary, the cave bear, although it was also larger than the existing type, seems to have been less dangerous to man, as it was no doubt less carnivorous in character. We also have a complete skeleton of the wolf and the cave hyæna.

Most of the skeletons which are shown here have been mounted recently. In addition to the remains which the museum already had, some new specimens were added lately, notably the two cave lions, which were an important find. These remains come from different parts of France, mostly in the southern districts. The Pyrenees region contains many caves in which scattered bones have been found in abundance for several centuries past, but at that time before the appearance of modern science little was known as to the origin of these remains, and in the seventeenth century they were considered as dragons' bones and thought to possess special curative powers when used in fine powder.

In the middle of the case will be noticed the two great cave bears, one of which is mounted in a sitting position, while the second, on the right, is in the position of walking. The cave bear, or *Ursus spelæus*, was considerably larger than the modern variety. The shape of the head was also somewhat different. The teeth are not as sharp and pointed, and the members are shorter and stouter. The form of the teeth seems to show that the animal lived on a less carnivorous diet than at present. These specimens were found at Herm in the Ariége district. Behind them on the left is another specimen of a smaller variety of cave bear which is mounted in a walking position. Many remains of these animals, mostly in the form of isolated bones of the skeleton, are found in different places in France and the rest of Europe, and they are specially abundant in the Pyrenees region. Whole skeletons are, however, of rare occurrence, and the present specimens are among the few which now exist. It seems that the cave bear was not as dangerous to man as one might imagine from its great size and ferocious appearance, and no doubt the most formidable enemy was the cave lion, which was of larger size than at present. Two of the latter specimens have been set up in complete form and as nearly as possible in natural positions. These are the two largest skeletons on the right of the collection. One of them comes from Herm and the other from Prajous, France. The latter was found by M. Serres. They are no doubt the most complete specimens of the cave lion which exist in Europe and will probably settle the much-disputed point as to the character of these animals. Different opinions are held by eminent authorities on this question, but as there were only incomplete skeletons to be referred to, no positive decision could be reached. Some naturalists thought that the cave lion did not differ appreciably from the modern type, or at any rate that they were the ancestors of our lions. Others maintained that it represented a distinct species and more nearly resembled the tiger. It would seem from the study of the present specimens that the cave lion is to be considered as the precursor of our modern lions, as it does not appear to show any marked differences except as to size. The difference in size is some 10 to 12 per cent over the largest lions we find at present. There seems to be no resemblance with the tiger as regards the special features of the latter. The formation of the skull and the members shows this. In front of the two lions (on the right) is a small skeleton of the wolf of that period. It was found at Gargas, in the Pyrenees region. It closely resembles the modern wolf in the main characteristics, but is somewhat larger. The cave hyæna, which is placed on the left of the case, completes the present collection. The appearance of this specimen, especially that of the head, shows that the animal maintains its reputation for ferocity. The cave hyæna is especially rare, seeing that this animal had the habit of preying upon remains of dead bodies, even of its own species, and generally we now find but a few scattered members. It differs from the modern variety in the shape of the members, which are somewhat longer, but otherwise there is no very marked difference.

One of the interesting points about the present collection is the method of mounting which Prof. Boule adopted. In place of choosing a stiff attitude, he made use of instantaneous views of the modern animals which most closely resembled the ancient varieties. By means of the photograph he obtained the true positions of the animals, whether in movement or at rest. Drawings were made from these photographs and these were used in mounting the specimens. The different bones are assembled together by a new method, which consists in the use of a series of steel rods which follow along the contours of the members and hold the bones in place without being prominently visible. This method does away with the use of vertical iron rods, which mar the appearance of the specimen, and at present the framework can hardly be seen, and the specimens have a natural and lifelike appearance.



Hyena. Cave Bear (walking). Cave Bear (sitting). Cave Bear (walking). Cave Lion. Cave Lion. Wolf.

SPECIMENS IN THE ROTHSCHILD COLLECTION OF CARNIVOROUS ANIMALS OF THE PERIOD OF THE CAVE DWELLERS.

EDUCATION IN JAPAN.

THE Frankfurter Zeitung, in a letter from Tokyo, publishes interesting data on education in Japan from the official "White Book."

The number of public schools in Japan is at present 27,138, in which 5,084,099 children are taught by 108,360 teachers; 93.23 per cent of all the children of school age went to these schools. In 1873, 29 per cent of school-age children went to the public schools; in 1883, 51 per cent, and in 1893, 59 per cent. A rapid increase in attendance is noted after the Chinese war. The percentage of attendance of boys compared with that of girls was 40 to 15 in 1873; the difference now

is only 7 per cent. The attendance at the various commercial and industrial schools was as follows: In 1901, 36,000; in 1902, 95,000—i. e., only 2,000 less than the number in the intermediate schools. The university for women held its commencement exercises recently, 86 graduates receiving the so-called academy diploma and 132 the university diploma. Of those receiving the university diploma 73 had studied housekeeping, 45 national literature, and 14 belonged to the "English" faculty. This university was founded for the purpose of educating women to be good wives and mothers.

PROGRESS OF ASTRONOMY.*

Every year, at the same epoch, your president is called upon to present a *résumé* of the most recent progress of astronomy. This progress is continuous and is pursued from one year to the next, for, you are aware, the work of astronomy is essentially one of long duration. When an observer undertakes a new research on the heavens he must first recognize that the universe is vast and human life is short, and that the achievement of his enterprise will be perhaps reserved for his successors even should he become a centenarian. Thus it rarely happens that the news of the definite conclusion of an astronomical work can be presented before you. Nevertheless the year 1905 will see the end of a measurement which has been undertaken three years ago by the united observatories of Paris and Greenwich. The difference of longitude between the two meridians is an important point, seeing that it serves to connect together the important astronomical and geographical researches carried out in France and England, and the uncertainty on this point seemed to reach 0.2 second of time. It thus seemed necessary to measure again the difference of longitude with all the care possible. Two corps of observers proceeded with this operation, using four telescopes exactly alike, placed two at Paris and two at Greenwich. The operators changed about systematically so as to equalize the causes of error. The observations lasted for several weeks, while the secondary corrections and reduction calculations occupied a period of two years. The result proved satisfactory. The French astronomers found 9 min. 20.974 sec., and the English, 9 min. 20.934 sec. The difference is thus only 0.042 second instead of 0.2.

A second determination, which is much more considerable than the preceding, has also been recently finished. This is the reduction of the observations of the contacts of Venus and the measurement of the photographic plates which were taken in 1882 during the passage of Venus on the sun. M. Bouquet de la Grye was charged with this important work. He continued it twenty-two years and now has the good fortune to bring it to a successful end. This eminent savant has well merited the gratitude of astronomers. The question was to determine the distance from the earth to the sun, which is the unit of distance in astronomy, or what is the same thing, the angle under which our planet is seen from the sun. M. Bouquet de la Grye found for this angle 8.80 seconds, a number which is very near what the recent observations of Eros gave. Besides, the measurement of the photographic plates gave him some very exact values of the diameter of Venus. Again, the measurement of the plates gives some good values of the sun's diameter. We must remark that this diameter has not in itself an exactly determined value. The sun is not a solid sphere with a sharp contour, but a gaseous mass whose brilliancy lessens in a continuous manner near the periphery. The number given by the passage of Venus, 8.80 seconds, is very near what has been deduced from the observations of Eros, which is 8.797 seconds. The reduction of the observations made upon Eros is not entirely finished. It will be remembered that the small planet passing very near the earth shows a parallax which is relatively large and is easy to measure, and its movement will accordingly give a measurement of the solar parallax which is more precise than that which is deduced from the passage of Venus. Some fifty observatories in all countries are pursuing the determination of the orbit of Eros under the direction of the Paris Observatory.

One of the most remarkable discoveries of the year is that of a ninth satellite of Saturn, named Phœbe. This body was perceived in 1899 on one of the plates which were obtained with one of the great American telescopes. It was found again in 1904, and Mr. W. Pickering followed its movement from the 16th of April to the 10th of November, thus deducing the elements of its orbit. The period of Phœbe is 547 days. Its distance from Saturn is 8,430,000 miles, while its diameter is 198 miles. Seen from the earth, it is a star of the fifteenth magnitude, but when observed from Saturn it is a star of the fifth or sixth magnitude. Phœbe appears to have a retrograde movement; and here we have a case which is so singular that it deserves to be verified by new determinations which may be made later on when the relative position of Saturn and the earth shall have changed considerably. Laplace's hypothesis easily explains that all the movements of the bodies in our solar system are direct, and are not so easy to be adjusted to the case of a retrograde movement. It may appear surprising at first sight that we may know the movement of Phœbe exactly enough to affirm that it has a 547-day period and that we hesitate still to affirm that it is retrograde. In fact, there is an effect of perspective which we are obliged to interpret. Phœbe's orbit presents itself in the form of a flattened ellipse. The northern branch of this ellipse may be the perspective of that branch of the orbit which is nearest to us, or it may be the contrary. Thus we may doubt as to the matter, and the uncertainty will only disappear when measures have been taken for another position of the globe. Saturn is already provided with rings which may be considered as a collection of satellites, and besides, there are nine distinct satellites. We may presume, no doubt, that the ninth satellite is not the last.

Jupiter, in turn, has now a sixth satellite discovered recently. It has only been observed twice as yet. Its period of revolution is 248 days. The number of small planets goes on increasing each year. The increase was 59 in 1904. Three new comets have been discovered this year and all three in France. The first two were discovered by M. Giacobini the 17th of December and the 27th of March, at the Nice Observatory. The third was found by M. Borrelly on the 30th of December at Marseilles. The number and intensity of the sun spots have not ceased to increase during the year. M. Janssen has obtained some fine photographs of the sun and the spots at the Meudon Observatory. The discovery of a variable star was formerly a rare and extraordinary occurrence. Now that the methods of observation have been perfected, the number of variable stars has increased to such an extent that it becomes difficult to keep account of them and even more so as to their variations. The English astronomers point out the need of an international understanding in order to pursue the work. The stars having variable periods can no doubt be ranged among the double stars, their change of brightness being due to the interposition of a satellite. The double stars properly so called comprise two components which the eye and often the telescope are not able to separate, but which we distinguish by the aid of the spectroscope. The latter method measures their speeds counted in the direction of the visible ray and thus allows of finding the period of their displacements which in themselves may be too far off to be visible to us. It is by the same method that we know the radial speed of a great number of stars. The spectroscope measures their speed no matter what may be their distance and even when their displacements, perpendicular to the visual ray, become invisible. Hence in a great number of cases it is easier to know the radial speed than the speed of displacement over the celestial sphere. These spectroscopic methods have been perfected and applied often by M. Deslandres, at the Meudon Observatory. He used it several times to calculate the movement of groups of double stars.

In the present year we will have an eclipse of the sun of long duration, nearly three minutes, which will take place on the 29th and 30th of August. It will be visible in its totality in many places which are easily accessible. The line of totality passes by Labrador, the north of Spain, Sfax, Philippeville (Algeria), and Egypt. Numerous are the expeditions which different countries are fitting out for observing the eclipse. Most of the leading countries are taking part in this research. The main observatories in France, led by the Bureau of Longitudes, are making an agreement to study it methodically. A credit voted by Parliament has allowed the construction of modern instruments. The Nice Observatory, owing to the liberality of M. Bischoffsheim, its founder, is especially well equipped for observing and photographing the eclipse. All the observers will study it by different methods, especially photographic and spectroscopic, relating to the different phenomena which the brightness of the atmosphere conceals on ordinary occasions and which only become visible during the eclipses. They will photograph the interior corona of the sun, which is very brilliant, and its exterior corona, which is very weak and quite extensive. The spectra will be fixed, if possible. Lastly, several observers propose to find whether there are any planets near the sun, between it and Mercury and near enough to have their light quenched by the sun's light in ordinary cases.

These different expeditions from all countries will be provided with an instrument whose use I proposed several years ago and which I call the "cœlostat." At present it has been given a successful trial and furnishes a fixed image of the heavens. It is composed simply of a mirror fixed upon an axis to which it is parallel. This axis, directed according to the line of the poles, makes a revolution in 48 hours. The image of the heavens, seen in the mirror, appears completely immobile, as the slow movement of the mirror exactly compensates the movement of the heavens. We can then turn our telescopes or other apparatus, carried on fixed supports, upon the mirror. The French observers will thus utilize telescopes of 10 to 15 meters focus, while the American astronomers will use lengths of 40 meters. It would be difficult, especially upon an expedition, to replace the cœlostat by equatorial telescopes of such large dimensions.

In this connection I may mention another apparatus which is having its first trials at the Paris Observatory and with which I hope to measure the co-ordinates of the stars. A photographic telescope follows the stars and takes a plate of a certain region of the heavens. At the same time an optical device operated by clockwork projects on the plate a series of bright lines which are fixed on the plate and mark the successive positions of the meridian. This uranograph, when once it is regulated, works automatically. When developed, the plate carries at the same time as the stars the system of co-ordinates, longitudes, and latitudes as on a terrestrial map. It only remains to measure the plate which has been thus obtained. The apparatus is free from personal errors which occur more or less in the present observations made with the meridian telescope.

The general photographic map of the heavens which has been undertaken under the initiative of the Paris Observatory by some twenty observatories in different parts of the globe, will soon be finished as regards the stars of the catalogue. Paris, the Vatican, Helsingfors, and Potsdam have published the provisory co-ordinates of their photographic plates. On the contrary, only one-third of the detailed plates of the map of the heavens have been executed. Referring to the recent work of the Observatory of Juvisy, near Paris, which M. Flammarion founded and still directs, the observatory is continuing the series of researches which it began more than twenty years ago, as the following short *résumé* will show. This institution, founded in 1883, has been continuing especially the study of the surface of the planets. Observations of Saturn, whose position is unfortunately very much to the south, have been made at times when the weather permitted. The observers were able to take numerous drawings of Jupiter and find out some interesting points, especially as regards the movement of the vast somber region of the southern tropical zone. The revision of the catalogue of clusters and nebulæ of Messier occupied a certain number of nights. However, some of the clusters of the southern hemisphere could not be photographed except by a very pure sky and a moonless night, so that the work is not quite completed. M. Benoit wished to take up some thorough researches so as to discover the planet which is supposed to lie outside of Neptune and which very likely moves slowly about the distance 50. Unfortunately the scarcity of clear nights in our regions and, besides, the insufficiency of the outfit have only allowed him to make a trial of his method. The observers have been able to commence a series of photographic researches which will perhaps give a little more precision in the determination of the relative brilliancy of the sun, moon, and principal stars. A first approximation shows that the full moon is 20,000 times as brilliant as Vega, which will give it about the magnitude 10.5. But this is only a rough result of some trials which were made with the view of finding out the best way of overcoming the many difficulties which are met with in applying the present method. Some observations on occultations of stars by the moon, of comets, conjunctions, etc., have also been made here. Lastly, we mention some measurements of the sixty-first star of the Swan, that double star which is so interesting and which in spite of all the periods we calculate, continues to give us doubt as to the evidence of an orbital movement. Climatologic observations have been continued by M. Loisel.

At the observatory of the Société Astronomique itself considerable work is being done and it has been quite successful. M. F. Baldet undertook the construction of a spectrograph with three prisms which is to be used in researches on celestial physics. At the same institution, M. Emile Touchet, our assistant secretary, has obtained several photographs of the Brooks comet (1904 *a*), the eclipse of the moon of February 19 last and several stellar regions. Attempts are being made to obtain stereoscopic photographs of stars having large proper motion like 1830 Groombridge. Our colleague succeeded in photographing a lightning flash which shows a bright incandescence of the air and has also communicated a simple process for measuring the solar surface as regards sun spots. M. G. Blum continues his attempts to photograph the solar groups as well as his work in stellar photometry.

* Paper read before the Société Astronomique de France by Prof. G. Lippmann, president.

THE DANGERS OF THE DOMESTIC USE OF ILLUMINATING GAS AND THE MEANS OF AVOIDING THEM.*

By Henry Leffmann, M.D.

The employment of illuminating gas manufactured from coal is about a century old. The original method, exclusively in vogue for many years, was by destructive distillation of soft coal. The operation is simple. The coal is heated strongly in a closed vessel, and the gases produced are cooled, purified, and distributed. The impurities of the crude gas are numerous, but of only few types. Ammonium compounds and sulphur compounds are the most objectionable, and much attention has been given to devising methods for their removal, which in well-operated works is satisfactorily accomplished. The purified gas as conducted into the storage tanks consists principally of hydrogen and hydrocarbons, among the latter being methane, ethene, and benzene. Some carbon monoxid is also present.

Laboratory experiment and clinical experience have shown that gas made in this manner has not very high toxic qualities. The hydrocarbons and hydrogen are rather negative than positive. They are incapable of supporting life, but are not active poisons. The gas always has a characteristic odor that gives warning.

During the past quarter of a century another method of making illuminating gas has been developed, and on account of its simplicity and comparative economy it has largely replaced the older method. This so-called "water-gas" is made by forcing steam on hot coal, anthracite or coke. The action is not distillation, but partial combustion; the steam oxidizes the coal to carbon monoxid, and is itself reduced to hydrogen. These are combustible gases, almost inodorous and producing an almost non-luminous flame. In this form the gas is suitable for heating purposes. It is sometimes termed "fuel water-gas." To fit this gas for illuminating uses, it is enriched, that is, impregnated

* Read before the North Branch of the Philadelphia County Medical Society, May 16, 1905.

with hydrocarbons from petroleum, coal-tar or common oils.

A striking characteristic of water-gas is its toxic power, due to the large amount of carbon monoxid. As this is without odor or irritant action on animal membranes, it may be breathed for a long while unconsciously. It possesses a degree of free affinity, which causes it to combine with hemoglobin to form a body (carbon monoxid-hemoglobin) that is not susceptible of decomposition by free oxygen. Artificial respiration does not remedy this chemical asphyxia. Indeed, up to the present time, no satisfactory method of combating this condition has been devised.

In matters of this kind the economic features are almost always the controlling ones. In spite of the progress of sanitary science, the general management of municipal affairs and of households is along unsanitary lines. It is known, for instance, that unfiltered surface water is unfit for drinking purposes, yet it is the common source of public supplies. So, in the matter of illuminating gas, the more highly toxic water-gas has replaced the older form; the greater danger has been ignored in consequence of economy in cost. The protests made against its use years ago have been disregarded, and the result has been a steady increase in the number of deaths from gas poisoning. Fifty years ago such cases were rare; to-day they are common. Indeed, so far as Philadelphia is concerned, it is noted that illuminating gas and carbolic acid have replaced, for suicidal and accidental poisonings, the arsenic and laudanum of the civil-war period.

The cheapening of the gas supply, representing a reduction to nearly one-half the cost of old-fashioned coal-gas, has led to its extensive use for heating purposes, more especially for cooking. Most of the apparatus furnished for these uses is constructed with but little regard to sanitary requirements. So far as the heating apparatus is concerned, it is used in about the same manner as our barbarian ancestors used their tent fires, except that the ventilating opening in the apex of the tent does not find any analogue in our own rooms.

The gas stove, for cooking, does not represent so serious a menace to health as does the simple heating apparatus. The former is generally employed in the warmer season, when there is much natural ventilation; the most serious difficulty with it is the striking back of the flame, which causes imperfect combustion, with the formation of offensive and poisonous compounds. These burners are generally constructed on the Bunsen principle, but are not provided with a collar by which the air current can be controlled to adapt it to the gas current. Slight changes of pressure will cause interruption of the combustion, with the result that the flame passes back to the inner jet.

For the heating of bedrooms and bathrooms, now becoming a common practice in cities, apparatus has been designed which, though called "stoves," are merely batteries of burners. They appear to be rather wasteful, since there is little metal to be heated and therefore little radiating mass. They are connected usually by a cheap grade of tubing, that soon becomes brittle and leaky. A special, highly objectionable feature is a stopcock attached to the stove, so that the gas supply can be turned off at that point and the connecting tube still remain open to the flow of gas; if this tube leaks, gas continues to flow out into the room. In this way many accidents to life and to property are caused. The convenience of this lower valve leads to its frequent use. During the past winter I have had considerable experience with these appliances and I have found them more than once leaking so badly that a flame an inch long could be obtained from points in the connecting tube.

The modern water-gas is of such insidious nature that a sleeper can easily absorb a fatal quantity without being aroused. Let us suppose that the condition of the atmosphere is such that at each inspiration 1/1,000 of a grain of the carbon monoxid present is absorbed. After the first inspiration, the blood will contain this quantity and the equivalent quantity of hemoglobin will be thrown out of function. At the next inspiration, another 1/1,000 of a grain will pass in, but the first portion will remain, so that now 1/500 will be present. At the next inspiration the quantity will be increased to nearly 1/333, and so on.

Hüfner states that 1 gram of hemoglobin will take up 1.3 cubic centimeter of carbon monoxid. Da Costa gives the average of hemoglobin in normal blood as 14 grammes to 100 cubic centimeters, therefore 18.2 cubic centimeters, say 20 cubic centimeters, of carbon monoxid would render the hemoglobin of 100 cubic centimeters of blood useless; 20 cubic centimeters of carbon monoxid weighs about 4/10 of a grain. From this rough calculation it is easily seen that even a small percentage of carbon monoxid can produce serious poisoning.

It is not appropriate to present the analytical data in detail, but the following table shows the principal ingredients of water-gas and coal-gas and their ordinary percentage by volume. It is taken from a recent edition of Kent's "Engineer's Pocketbook," and is presumably from authentic sources. Natural gas is inserted for comparison:

	Natural gas.	Coal Gas.	Water Gas.
Carbon monoxid	0.5	6.0	45.0
Hydrogen	2.2	46.0	45.0
Methane	92.6	40.0	0.2
Ethene	0.3	4.0	....
Nitrogen	3.6	1.5	2.0
Carbon dioxid	0.3	0.5	4.0
Heat units per cubic ft.	1,000	735	322

It will be seen that unenriched water-gas is principally hydrogen and carbon monoxid, and that its fuel value is rather low. When the gas is enriched, the so-called heavy hydrocarbons, compounds rich in carbon, are much increased, and the fuel value, as well as the illuminating power, is much improved. The following are partial statements of composition of enriched water-gas, such as is commonly supplied in American cities. The figures, except for heating power, are per cent by volume. Not all the ingredients are given:

	No. 1.	No. 2.
Carbon monoxid	28.0	23.0
Hydrogen	37.0	36.0
Methane	19.0	21.0
Ethene	11.0	13.0
Heat units per cubic foot	650	658

As a comparison of heating power between the two types of gas, the figures given by E. G. Love for 1892 (Kent's handbook) may be quoted: New York city gas (carbureted water-gas), costing $1.25 per 1,000, yielded 715,000 heat units per 1,000 cubic feet. London gas (presumably all coal-gas), at from 60 to 70 cents per 1,000, yielded 668,000 heat units per 1,000 cubic feet.

It would be a great mistake, however, to assume that because of these objections we should abandon the use of gas, or even go back to original coal-gas. The object of this paper is to call attention to the dangers in order that renewed attention may be given to avoiding them. Gas is only dangerous when we lose sight of its composition and effects. Its advantages in the household are great. Properly used, it makes for sanitation instead of against it. At the cooking range, it simplifies very much the details of food preparation, relieves the housekeeper of much hard labor, and saves time, temper, and trouble. The facility with which it may be used to obtain hot water at short notice is a great advantage, both to the well and to the sick.

The need in regard to house use of gas is better apparatus and better connection of that apparatus with pipes. Gas producers and sanitary authorities should join hands in enforcing regulations in these respects.

Let me take some of these reforms up in more detail. I suggest that the sale of inferior tubing be forbidden. Excellent rubber tubing can be obtained for a reasonable price. Taking into consideration my own experience this winter, I should say that the higher priced tubing is the more economical, for it outlasts by a long while the inferior grades. The inferior grade often leaks when purchased. It is sometimes but little else than an imitation of rubber, its quality being concealed by a brilliantly colored covering. I have seen this tubing become in a short time so brittle that it could be broken like a dry twig.

Gas stoves for heating rooms should not have stopcock connections at the base unless attached by metal tubes with tight joints to the house mains. If attached by rubber tubes, there is great danger of the gas being only turned off below. This method of turning out the stove is the usual one with women and children, who can not conveniently reach the higher burner. The apparatus, however, should be so constructed as to prevent the rubber tube, even when of the best quality, remaining in free connection with the house main when the gas is not lighted.

Improvements should be made in the room stoves by which a larger radiator effect could be obtained by a given gas consumption. So far as I have been able to judge, the principal heating effect is the distribution of the products of combustion through the room. This, of course, is insanitary and doubly so because the shortness of heat forbids the free opening of windows. I believe that stoves for heating purposes should be placed only where the products of combustion can escape freely to the chimney. It must be borne in mind that the carbon monoxid poisoning is not the only danger in the use of gas. The products of normal combustion are more or less toxic, and the products of imperfect combustion are still worse.

All burners on the Bunsen principle should be provided with collars for controlling the air supply, and the dealers in these articles should be expected to instruct purchasers in the use of the collar. The escape of the partially burned hydrocarbons resulting from the striking back of burners is very detrimental to health.

The use of illuminating mantles with gas has become very common of late years, and is a great advantage in several ways. The mantle, however, may interfere with proper combustion. It is not at all uncommon to notice a disagreeable odor proceeding from these burners, and this is usually due to displaced or worn-out mantles. The rubber tube connecting the ordinary drop-light with the house main is apt to be a source of danger for the same reason as noted in connection with the stove; the gas may be turned off for convenience, at the base of the light, instead of at the original attachment, and thus may leak into the rooms.

These points may seem trifling, but practical experience has shown that the dangers exist. A rational co-operation of the makers of gas and gas stoves on the one hand, with physicians and sanitarians on the other, will greatly improve the condition of the air of our living rooms.

The mortality statistics of Philadelphia and New York show strikingly the increase in the poisonous qualities of illuminating gas since the extensive introduction of water gas. Both cities have been extensive users of gas for over 50 years. A report presented in 1854 by the trustees of the Philadelphia Gas Works to City Councils states that during the preceding year 250,000,000 cubic feet of gas had been manufactured. This was, of course, for the old city alone, as the consolidation act was not approved until February, 1854.

Deaths from poisoning by illuminating gas do not occupy a place in the mortality reports of Philadelphia or New York until about twenty years ago.

For New York, I have the figures given by Dr. Witthaus in Witthaus & Becker's "Medical Jurisprudence and Toxicology," and the report of the New York Board of Health for 1902. The figures given by Dr. Witthaus are in summary as follows:

DEATHS IN NEW YORK CITY ATTRIBUTABLE TO POISONING BY ILLUMINATING GAS.

	Accidental.	Suicidal.
From 1867 to 1880, 14 years	13	3
From 1880 to 1892, 13 years	157	45

Up to 1887 the entries are very few; for the last four years of the second period above given the data are:

	Accidental.	Suicidal.
1889	33	11
1890	36	4
1891	35	19
1892	53	11

The report for 1902 gives:

Suicide by "asphyxia" (hanging and strangulation excluded)	118
Deaths by inhalation of "noxious gases" (not suicidal)	235

As a cause of death, illuminating gas first appears prominently in the Philadelphia reports for 1899, but the board's reports for 1897 and 1898 do not give detailed statements and the sudden appearance of this factor may be apparent only. The data are also somewhat confused by the introduction of an item, "suffocation," without further specification. I have endeavored to secure a little more significance to this by showing the proportion of deaths under 1 year and over 15 years attributed to it. I suspect that a notable proportion of suffocations in adults is due to gas poisoning.

ABSTRACT OF PHILADELPHIA MORTALITY REPORTS.

Year	Suffocation—Special Cause Not Given.			Suffocation by Illuminating Gas.		Suicide by Illuminating Gas.
	Total.	Under 1 year	From 20 to 80 Years.	Total.	Under 15 years.	Total.
1893	No entry	...	...	No entry	.....	No entry.
1894	1	...	1	...	.....	1
1895	1	1	...	...	.....	
1896	No entry	...	...	No entry	.....	No entry.
1897	...	.....	No detailed statistics.	.....	.....	
1898	...	.....	.....	.....	.....	
1899	27	22	5	16	1	30
1900	23	12	9	5	1	39
1901	62	25	31	1	0	26
1902	42	18	16	7	0	36
1903	50	21	21	29	2	45

The Philadelphia classification differs considerably under different administrations, and some of the terms used are confusing. It is evident that, although suicide is an important factor in mortality statistics, it is not a cause of death in the sense that pneumonia or yellow fever is.

PATCHOULI PLANT AND ITS USES.

CONSUL SKINNER, of Marseilles, France, in response to numerous inquiries received by him from California and other sections of the United States regarding the patchouli plant, writes:

The patchouli plant is a native of India and China, where it is quite common. It is also grown successfully in Ceylon, Paraguay, and the French possession of La Réunion. The leaves and branches possess a musk-like perfume, and upon distillation furnish the essence of patchouli. It resembles the sage plant in height and form, but its leaves are less fleshy. Our first knowledge of this plant dates from about 1850, when the first importations were received in London. At that time real India shawls were selling at extravagant prices, and buyers identified the genuine by their odor, they being perfumed with patchouli. French manufacturers, in order to imitate the India shawls successfully, imported the plant and perfumed their wares with the essence, thus passing off their goods as genuine. Since that time perfumers have taken up the industry for their own account.

The cultivation of the patchouli plant has been going on for centuries in China and the Malay Peninsula. It requires a light soil, level land or slightly elevated hillsides. The plants are transplanted in the rainy season 18 inches apart and then covered with leaves. Six months later the first cutting takes place. Each hectare (2.471 acres) furnishes at each gathering about 344 pounds of dried leaves and branches and 185 pounds of stems. The dried branches bring about 11 cents per pound, and, as there are two cuttings every year, the gross receipts of the growers average about $25 an acre, and at times as much as $40.

The crop is classed under three heads: (1) Leaves; (2) leaves mixed with young shoots and a little wood; (3) large stems. In Java the patchouli leaves are often mixed with 25 per cent of dilem leaves. The patchouli leaves imported from Calcutta and Bombay contain 75 per cent of stems and furnish an essence of less value than the Malay Peninsula plants. The Java patchouli is of fine appearance, but is poor in aroma. The essence is occasionally extracted in the countries of origin, but the distillation of the leaves is undertaken on a large scale only in Europe. The leaves are first cut, then hydrated, left for twelve hours, and then distilled by steam. The yield in es-

sence is from 1¾ to 3 per cent. The essence is a yellow-green liquid, which turns brown in time; it is rather thick, possesses a penetrating odor, which is disagreeable in concentrated condition, but agreeable or at least very characteristic when diluted and associated with other perfumes. The density of the essence at 29.4 deg. C. is as follows: Penang green essence, 0.957; Penang brown essence, 0.958; French brown essence, 1.012; ordinary commercial essence, 1.0119. Patchouli essence is soluble in 10 to 12 parts of alcohol. The material is at times falsified with cedar essence.

The odor of patchouli essence is so strong that few people can endure it. Therefore it is always used in diluted form. When mixed with another essence, the second is imperceptible. The dried leaves are often broken into powder, placed in sachet bags, and disposed of in drawers and closets, as a protection against moths.

REINFORCED CONCRETE.

THE combination of iron with Portland cement concrete is one of the most important advances made in the art of building in many years. The compound material, called reinforced concrete or ferro-concrete (German, *Eisenbeton;* French, *béton armé*), has recently been employed to an extraordinary extent in almost every branch of the art, and is constantly finding broader and bolder application. It has competed successfully with iron and steel, as well as with wood,

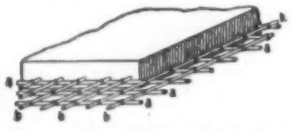


FIG. 1.—MONIER SYSTEM.

stone, and brick, and, as a matter of fact, it is better adapted to a number of structural uses than the materials which were formerly employed.

Reinforced concrete construction originated in France, where it has been employed more extensively than in any other country. About forty years ago Monier first diminished the weight and the fragility of flower pots by making them of cement, reinforced by imbedded wire. The idea was soon extended to other hollow objects, such as pipes and tanks for water and gas. Then came its application to such parts of buildings as floors and partitions. It was not until about fifteen years ago, and after the methods of reinforcement had been improved and adapted to larger undertakings, that the material began to be used extensively in general construction.

FIG. 2.—GRATING USED IN MONIER SYSTEM.

Until recently official building regulations have restricted its employment in northern Germany to walls and floors, in conjunction with iron columns and girders, but in the south, and in other countries, entire floors, stairs, and roofs of halls, theaters, factories, and warehouses, and even whole buildings have been made of reinforced concrete, without any detached steel or iron supports.

The fundamental principle of reinforced concrete construction is that the structural elements are made of concrete in which iron rods are imbedded in such a manner as to take upon themselves the tensile stresses, while the concrete, which offers little resistance to tension but much to compression, receives the pressures and carries them on to the ultimate supports.

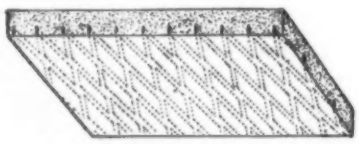
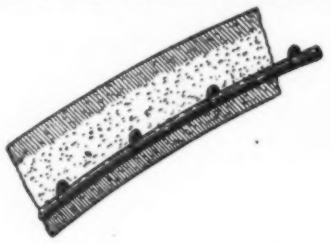


FIG. 3.—MONIER SYSTEM USING GRATING.

The concrete, furthermore, cements the iron rods into a rigid whole, so that none of them can move independently of the others. The concrete is nearly always rammed, seldom merely cast, in molds, and consists usually of one part of cement, three of sand, and three of gravel or fine crushed stone.

The initial distrust of this combination of iron and concrete has now been completely overcome by the results of experiment and practice. It has been proved that iron and concrete possess almost equal coefficients of thermal expansion, so that cracks are not liable to occur, that there is a strong mutual adhesion between them, and that the concrete completely protects the iron from rust. This property of concrete is so well known that inaccessible parts of iron ships, in the bow, stern, and hold, are now concreted.

Reinforced concrete construction combines the advantages of masonry and of pure iron construction. Among the chief merits of concrete buildings are durability and security against fire. In addition, they are comparatively light in weight, inexpensive and economical of space, owing to the thinness of their



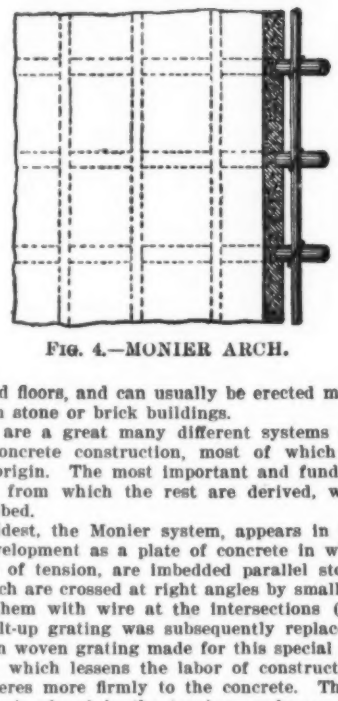


FIG. 4.—MONIER ARCH.

walls and floors, and can usually be erected more rapidly than stone or brick buildings.

There are a great many different systems of reinforced concrete construction, most of which are of French origin. The most important and fundamental systems, from which the rest are derived, will now be described.

The oldest, the Monier system, appears in its simplest development as a plate of concrete in which, in the zone of tension, are imbedded parallel stout iron rods which are crossed at right angles by smaller rods, tied to them with wire at the intersections (Fig 1). This built-up grating was subsequently replaced by a strap-iron woven grating made for this special purpose (Fig. 2) which lessens the labor of construction and also adheres more firmly to the concrete. This grating, also, is placed in the tension, or lower, stratum of the plate (Fig. 3).

Small Monier arches (Fig. 4) are built on a similar plan, while larger ones are reinforced with iron at the

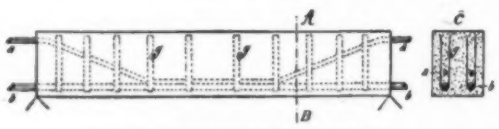


FIG. 5.—HENNEBIQUE BEAM.

top as well as the bottom. In arches the iron both strengthens the concrete against the normal pressures and withstands the tension which may be developed under certain conditions. In vertical walls the reinforcement is symmetrical, consisting either of one layer of iron at the middle or of one near each face.

More extensively employed than Monier's system is that of Hennebique, which permits the construction of beams and columns, as well as floors and arches. In the Hennebique beam (Fig. 5) there are two layers of round iron rods, the lower of which takes up most of the tension but is aided in the middle part, where the tension is greatest, by the upper layer of rods which here joins it. At the ends the rods of the upper layer are bent diagonally upward so that, like the diagonal tie-rods of a truss bridge, they carry up part of the tension of the lower chord, or stratum, to be sustained by the pressure of the upper, or stratum of compression. This framework of rods is further stiffened by vertical stirrups of strap iron (Fig. 6).

FIG. 6.—HENNEBIQUE ANCHOR STRAP.

Floors are made in the same way as beams. In columns and arches the rods are subjected to direct pressures. The construction of a Hennebique column is illustrated in Fig. 7. The Hennebique arch contains a top and a botttom layer of rods and differs from the Monier arch only in having the two layers rigidly connected.

In Moeller's system of reinforcement iron is imbedded in the upper or compression zone of a horizontal concrete plate while the tension at the bottom is sustained by iron ribs, arching downward from the ends.

Melan's system, designed especially for arches, makes use either of profile iron or of gratings. Both of these systems are employed chiefly in engineering works.

Though, as in the instances cited above, both profile and strap iron are used to some extent, the iron of reinforced concrete is most commonly in the form of round rods. Occasionally, especially in the United States, square bars twisted cold, or round bars flattened in places, are employed for the purpose of increasing the adhesion between the iron and the concrete (Fig. 8). Where two rods come into contact they are tied together with wire heated to bright redness. They are, furthermore, connected, at intervals of from eight to twenty inches, by anchors of strap iron, twisted wire loops, or welded links (Fig. 9). The prolongation of a rod, when necessary, is effected by welding.

We come now to the description of the numerous applications of reinforced concrete, beginning with ordinary storied structures, in which it may be used for columns, girders, floors, arches, walls, roofs, stairs, balconies, bay-windows, and almost every other part. For fireproof floors, in particular, a great many practical plans have been devised. Fig. 10 shows a Monier floor with imbedded grating resting on I-beams, and Fig. 11 illustrates Koenen's "arched plate," with curved iron rods which are hooked over the upper flanges of the supporting beams. Fig. 12 shows a Hennebique floor borne by Hennebique columns.

In the Eggert floor the reinforcement consists of a

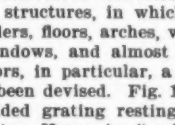


FIG. 7.—HENNEBIQUE COLUMN.

bottom layer of square rods, the ends of which turn upward and engage in the pressure zone above. These ends are either hooked or furnished with anchor plates, according to the magnitude of the stresses (Fig. 13, *a*, *b*). Fig. 14 shows a simple Eggert floor, Fig. 15 one supported by columns. A Hennebique column with a girder of peculiar construction is shown in Fig. 16, while Fig. 17 illustrates the combination of columns, girders and floor, showing the absence of separate iron supports.

(To be continued.)

AMERICANS LEARNING TO PACK.

A RECENT issue of the British Trade Review calls attention to the fact that goods going out of the United States into foreign ports are by no means so badly packed as some people would have the public believe. In pointing out existing evils affecting British trade, the Review says:

Sufficient attention is not given to the necessity of packing in a small compass. For transmission to a

FIG. 8.—TWISTED AND FLATTENED RODS.

distant colony this is important, because the smaller the cubic measurement in which the goods can be packed the less is the freight, storage, cartage, wharfage, and sometimes the duty.

American goods, and sometimes German goods, are more closely packed than British goods, without in any way increasing the risk of breakage or damage. Whenever a duty by measurement has been placed on any article in Victoria, it has been found that the Americans, and sometimes the Germans, have proved themselves able to place a greater quantity in a cubic foot than the British. The trade in lamp glasses, bottles, and some other items has been seriously affected by the difference in the closeness of the packing.

A feature of United States packing is the more general practice of making up articles into trade packages —that is, into packages which can be bought and sold in the cases in which they are imported. Clocks, lamps, and many such articles are sent in cases of unvarying size, and containing a suitable number of

FIG. 9.—CONNECTING LINKS.

articles for sale to retail shopkeepers, when similar goods from the Continent or from Great Britain would be sent in larger cases of irregular size, designed for no other purpose than to convey the goods to Melbourne. Further, the United States uses largely specially prepared pitch paper for lining cases, where the British use metal. The experience in Victoria is that the pitch paper is as effectual in preserving goods as metal, and that it is lighter and more convenient.

In the boxing or "get-up" of small goods the United States manufacturers excel. They use cardboard boxes in numerous instances where the British pack in brown paper parcels, and the United States practice is held to be preferable, for the reason that the box is

suitable for placing on the shelves of a shop. As regards the goods which are packed in boxes in Great Britain and the United States, the boxing is nearly always better done in the latter country, the boxes being stronger and more sightly. British goods can commonly be picked out in the stock of a hardware

FIG. 10.—MONIER FLOOR WITH GRATING.

store by the greater number of broken boxes. The excellence of the manila paper and cardboard boxes used in the United States has been a considerable factor in advancing American trade.

PAPER AS PROTECTION FOR IRON AND STEEL.*

By LOUIS H. BARKER.

ABOUT eleven years ago experimental investigation was begun with numerous well-known and established iron paint preservatives in order to ascertain by actual exposure tests the best one to resist the destructive action on steel structures of sulphurous gases in the form of smoke combined with the moisture of steam, and since that time fifty or more paints and combinations have been tried. Among them were asphaltum, rubber, graphite, carbon, lead and iron paints, and though the results showed varying degrees of resistance, it is remarkable that even with three coats of paint not one was found that did not show rust in less than a year. Of course it is to be understood that the exposures were made so as to subject the test bars to the severest action possible in order to obtain the quickest results.

In making the first series of tests new steel plates 10 inches square were used. As, however, the adverse conditions we were trying to overcome related to rusty steel, which is more difficult to preserve than new steel, rusty plates were substituted in all tests thereafter. And still further to endeavor to meet the existing conditions new plates were hung up and exposed to the smoke fumes until they became covered with sulphur scale. The thought was that an oxide scale due to

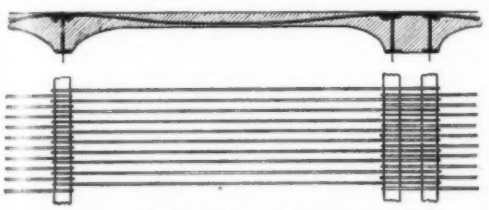


FIG. 11.—KOENEN'S ARCHED PLATE.

atmospheric exposure might give different results. This scale or rust formation on these new plates apparently varied not only in amount but also in the time of its formation, supposedly due to different chemical composition. As this might again give some variations in the experimental results, in order that all paints should be on as like footing as possible angle bars 11 feet long were made use of and as before hung in the smoke until rusted, then cleaned with wire brushes, each foot

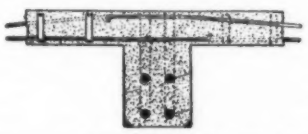


FIG. 12.—HENNEBIQUE FLOOR.

of the bar painted with a different paint and again hung up. The results, however, continued to be unsatisfactory.

RUST ACTION UNDERNEATH THE PAINT.

In examinations of the test bars from time to time it was seen that upon many of them the paint was intact, but with protruding points, which upon being pricked were found to be small rust formations pushing up the paint from behind, clearly indicating that it was not the failure of the paints, but the rust action on the inner surface that caused the damage. As no rust can form without the presence of moisture, and as all paints are pervious to moisture (as Dr. Chas. B. Dudley's careful investigations at Altoona, Pa., for the

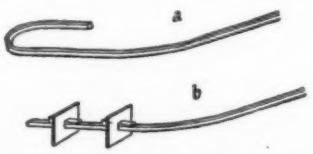


FIG. 13.—IRON PARTS OF EGGERT FLOOR.

Pennsylvania Railroad have proved), this led to the conclusion that it would be necessary in some way to tightly seal the surface. Many kinds of materials for doing this were tried with as many different results, until three years ago it was decided that a cheap paraffin paper answered the purpose best of all, and since that time all experimentation has been along that line.

* A paper read at the Atlantic City meeting of the American Society for Testing Materials, June, 1905.

Besides its application on experimental bars the paper covering has been tried in a small practical way against smoke action, and after two years and three months' exposure an examination of very recent date shows the outer paint, the paper and the first or adhesive coat all intact, and in many places where paper was removed for examination the adhesive coat not yet dry

FIG. 14.—EGGERT FLOOR.

and the surface of the steel the same as when painted.

With such satisfactory results from this paper process in the smoke tests it was concluded to make a large-scale application and severe test on a large number of I-beams supporting a floor over and within a few feet of salt water and upon which the rust was due not to smoke but to the almost continuous dampness and presence of sewer gases. This was done over a year ago, and up to this time no indication of damage of any kind is apparent.

The mode of application of the paper is as follows: After the rust is carefully cleaned off by means of stiff wire brushes a certain kind of tacky paint is applied, the paper then covered over and tightly pressed upon the painted surface, the joints of the paper slightly lapping. As soon as the paper is in place it is ready for the outside coat of paint. It will be observed that by this process the first coat of paint, the paper and the coat of paint over the paper can be applied with one scaffolding, thereby greatly reducing the cost, especially in high and dangerous places.

These experiments, extending over only three years, are of too short a duration to determine the value of paper as a protection for iron and steel, but they certainly bring out the fact, at least in the case of smoke and gases, that the action begins from behind the paint and not from in front by the disintegration of the paint.

THE MANEUVERING OF TURBINE STEAMERS.

WHILE it has been admitted, practically on all hands, that the steam turbine has considerable advantages over the reciprocating engine for ship propulsion, and that it is almost certain to be very widely adopted for high-speed vessels, there continues to linger some doubt as to facility in stopping and starting, reversing, and generally of maneuvering, turbine-driven steamers

FIG. 15.—EGGERT FLOOR BORNE ON COLUMNS.

into piers and confined harbors, says Engineering. This doubt should be largely dissipated by the results of the official trials of the "Dieppe," built for the London, Brighton & South Coast Railway and the Western Railway of France, for service between Newhaven and Dieppe. The trials which were carried out between the two ports named were interesting more for the novel requirements in respect of stopping and maneuvering than for their speed; but in this latter respect the performance of the steamer was certainly remarkable, in view particularly of the fact that the length of hull was limited, owing to the tortuous nature of the channel within Dieppe Harbor. This required that the length should not exceed 281 feet on the load-line. Fortunately, a scheme has now been approved, which, when carried out, will straighten the crooked paths. In the meantime the dimensions of the "Dieppe" had to be as follows: Length over all, 282 feet; length on the water line, 280 feet 6 inches; breadth, 34 feet 8 inches; depth, 14 feet 6 inches. On trial the mean draft was 9 feet 3 inches, and the displacement 1,360 tons. The vessel was required to make the double passage within such time as necessitated a speed of 21.19 knots. The run to the French port on Thursday, July 6, was made at the average of 21.523 knots, and the return voyage, on the following day, at 21.764 knots, giving a mean speed for the double run—nearly

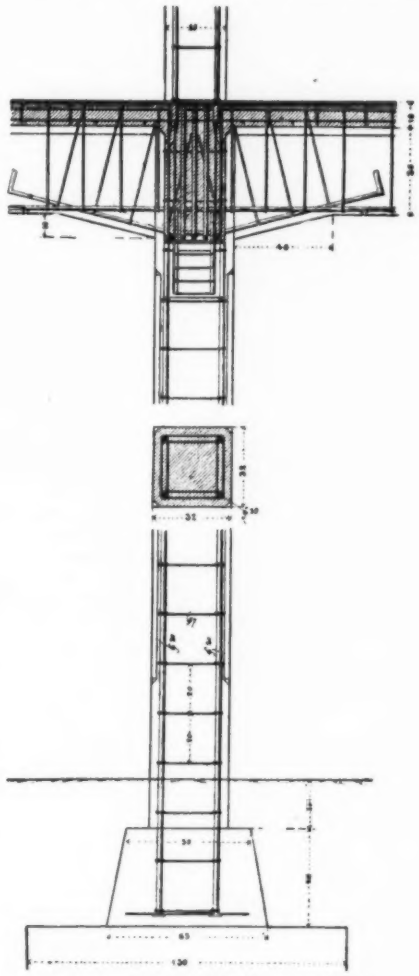


FIG. 16.—HENNEBIQUE COLUMN.

130 sea-miles—of 21.523 knots. When we come to describe this vessel fully, we shall give the details of engine performance, etc. In the meantime, it may be said that the three shafts, each fitted with single screws, and operated—the center shaft by a high-pressure turbine, and the two side shafts by low-pressure turbines—run at a mean speed of about 640 revolutions per minute. As we have already indicated, however, the interesting features were the rapidity with which full speed could be realized, and the time taken to reverse. Moving away from the quay, only the low-pressure wing-shafts and propellers were in use, as this greatly facilitated maneuvering. When the vessel

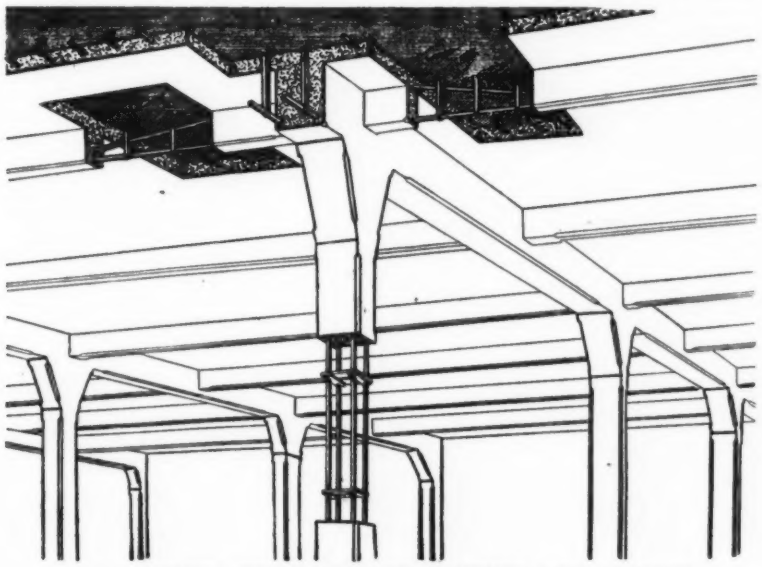


FIG. 17.—FLOOR SUPPORTED ON COLUMNS AND GIRDERS. HENNEBIQUE SYSTEM.

had got into the center of the harbor, and the order was given, "Full speed ahead," barely 2½ minutes elapsed before the high-pressure turbine was running at a speed of over 600 revolutions per minute. From the time that the vessel left Dieppe Quay until she was passing the lightship at the entrance to the harbor only four minutes elapsed, notwithstanding the tortuous nature of the harbor; this of itself is a very satisfactory performance in respect of maneuvering. Before

the vessel had entered Dieppe, the contract required that when running at a speed of 12 knots she was to stop within 100 meters. Two boats had been moored to mark this distance, and for two miles in advance of the first boat the "Dieppe's" turbines ran at the rate of revolution which previous performance on the measured mile had determined as necessary to give a speed of 12 knots; within six seconds of the order, "Full speed astern," the turbines were running astern, and in 41 seconds the ship herself was moving astern, the distance trayersed from the time the order was given to reverse until the ship began to go astern being 100 yards—several yards less than the requirements of the contract. Thus, as regards speed and maneuvering, every condition of the contract was fully satisfied.

CASE-HARDENING.*

By David Flather.

The term "case-hardening" naturally implies the hardening of the skin of an article, and in order to fully understand the process and its object we must briefly consider the facts and laws upon which it is founded. Carbon has a very great affinity for iron, which is limited only by their combining power on the one hand, and the conditions of their contact on the other. Carbon combines with iron at all temperatures above faint red heat, and advantage is taken of this fact in the production of steel by cementation—in fact, the process of case-hardening is in reality incomplete cementation followed by water or oil hardening.

By the term "hardening" we understand the production and fixing of the maximum hardness which any given steel is capable of yielding. All steels are brought to their greatest state of hardness by being heated to certain temperatures, followed by a more or less rapid cooling in such fluids as are most suitable for the kind of steel and the work it has to do.

Before proceeding to review the process it may be useful to set forth clearly the advantages we seek to obtain through its employment, and follow this by a brief consideration of the material on which we propose to operate. For many purposes in cycle work we require articles to have a perfectly hard surface, and yet to be of such a nature that there is no chance of their breaking in use. In many instances this result can be obtained with high-class crucible steel, but for axles, cups, cones, and many similar parts, it is extremely difficult to obtain perfect hardness combined with great resistance to torsional, shearing, or bursting strains. For such purposes nothing can meet these requirements so fully as can be done by means of case-hardening. The greatest risks in the employment of all steel often occur during its treatment by the consumer, and whether it be the finest cast steel or only common Bessemer, it is of first importance that it should be carefully and properly treated with a view to the work it has to do.

Both iron and mild steel have been employed as material for case-hardening; but this is the "steel age," and iron has, I think, long passed its day. The steel employed should be prepared, selected, and controlled from the beginning with the object of suiting it to its requirements. There are, of course, many points relating to its composition and treatment by the producer which can only be gained by long experience and by study of the requirements; but, as you will understand, I cannot treat of them here. Suffice it to say that the steel used should be low in carbon and capable of absorbing more carbon with great uniformity when heated under proper conditions; it should contain a minimum of deleterious impurities, and be perfectly sound and free from mechanical faults or weaknesses caused by overheating during the manufacturer's processes.

The process of case-hardening consists, then, in bringing the steel or iron articles into contact with carbon in closed boxes or pots, and raising them to the requisite temperature for a sufficient length of time; afterward the articles are reheated and cooled by quenching in oil or water.

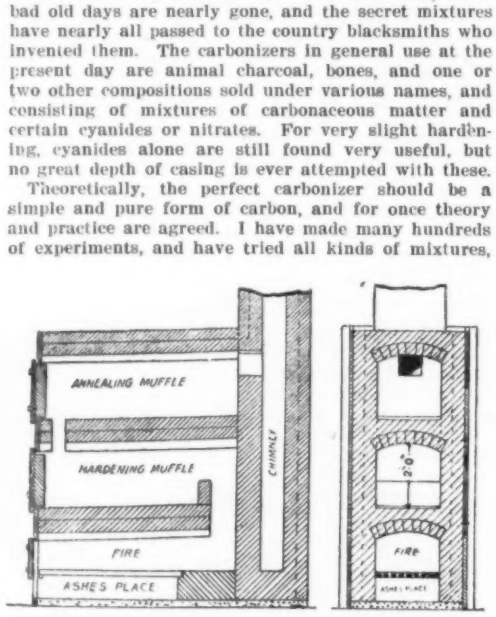
Equipment.—The furnace should be so constructed as to be capable of being raised to a full orange heat (1,000 deg. C.), and maintained at that heat with great regularity. It should be so constructed that neither the fuel nor the direct flame can come in contact with the charge—that is to say, that the flames should uniformly impinge on the sides and roof of the muffle in such a manner as to raise them to a high temperature, thus heating the contents of the muffle by radiated and not by direct heat. A furnace designed on this principle not only gives the best result, but is also most economical in the matter of fuel. The muffle chamber and flues must, of course, be constructed of firebrick, and the doors should fit closely and also be lined with firebrick. It is important that there should be a small peep-hole in the door, with a cover plate; a hole of 1½-inch diameter is quite large enough. This latter is really a most important detail, as it provides against the need of opening the doors in order to judge the heat, and is indeed the most accurate means of estimating the temperature by the eye. The furnace must be fitted with a reliable damper plate or other effectual means of controlling the draft.

I give a drawing of a small furnace which may, I hope, be useful as a guide for the erection. The cost of such a furnace is about £35. I have an upper chamber in this furnace, and though this is not necessary for case-hardening, it may in a small works be found useful to have such a chamber and employ it while case-hardening is being done, for the insertion of any articles which require annealing. This will add only very slightly to the amount of fuel used. Generally speaking, coal is the fuel employed for case-hardening; but there can be no doubt that, at least for large works, where a number of furnaces are kept going, gas-fired furnaces should give every satisfaction, not only as regards economy in working, but in the amount of control which can be kept over the temperature.

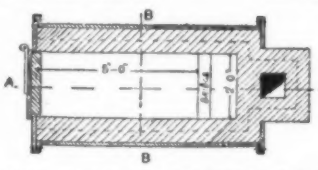
Hardening pots are made in both cast and wrought iron, the former being cheaper in first cost, but the latter bear reheating so many times that they are cheaper in the end. The pots should not be of too large dimensions, or there is great risk of articles in the middle of a charge not being cased to a sufficient depth. In my opinion no pot should be above 18 inches by 12 inches by 11 inches for such articles as axles, pedal pins, and the like; while for small articles like cups, cones, etc., 12 inches by 10 inches by 8 inches is large enough. The pots should each have a plate-lid fitting closely inside.

Perhaps in no part of the process has there been so many differences of method as in the question of the carbonizing material. At one time nearly every case-hardener had some secret and wonderful composition or mixture to which he attributed his success, and when he failed to get good results he followed the usual course and blamed the steel. However, those bad old days are nearly gone, and the secret mixtures have nearly all passed to the country blacksmiths who invented them. The carbonizers in general use at the present day are animal charcoal, bones, and one or two other compositions sold under various names, and consisting of mixtures of carbonaceous matter and certain cyanides or nitrates. For very slight hardening, cyanides alone are still found very useful, but no great depth of casing is ever attempted with these.

Theoretically, the perfect carbonizer should be a simple and pure form of carbon, and for once theory and practice are agreed. I have made many hundreds of experiments, and have tried all kinds of mixtures,



Longitudinal Section-AA. Cross Section BB.



SECTIONAL PLAN OF HARDENING MUFFLE.

but I have always found good charred leather to give the most certain and satisfactory results. I beg you to note that I say "good" charred leather, and I do this because most of what is sold under this title is very bad—it is not fully charred, and very often it is not leather; therefore I strongly advise that charred leather should be bought only from some firm who are actually in the leather or some allied business, and who use this trade as an outlet for their scrap leather. Even under such circumstances it is important to keep a strict watch over the deliveries, and especially to keep a good lookout for traces of copper and steel rivets—a sure evidence of old boots or old belting—neither of which is a desirable constituent in the composition. Buy the leather coke in lumps and have it powdered in your own works, taking care that it is not contaminated in the process, and that by the time it is required for use it is perfectly free from moisture.

As clay must be used for a luting around the pot lid, and is also frequently used for stopping off portions to be left soft, it is important to see that a good clay is used, and that it is free from grease. I mention this because I once had much difficulty in tracing to its origin a great irregularity in the hardening turned out by one of my friends. We tested separately every part of their method, and only after having tried everything I knew, I thought of the clay, asked where they got it from, and when they said from the mortar mill, I saw at once the source of the trouble. I asked to see their clay stock, and, sure enough, found among it several lumps of cog grease. This had been worked up into the clay, and directly it got into the muffle it melted; part ran into the pot and did the damage. I did not investigate the action any further, as our object was achieved. A change in the clay brought about a satisfactory change in the hardening results. Therefore, I advise that a careful watch be kept on the clay supply.

As all case-hardened articles have to be reheated before quenching, it is important that a suitable furnace should be employed for the purpose. It is not advisable that the reheating should be done in the case-hardening muffle, unless it is run specially for the purpose and at a lower heat. If possible a small gas muffle should be used for reheating, and indeed for all hardening work. A properly constructed gas muffle can be regulated with great exactness, and this is very important in all hardening.

A good supply of clean water is very necessary, and where oil is used care should be taken to have as large a tank as possible.

Although the arrangement of the shop hardly comes within the scope of this paper, yet it may be worth our while to note certain points which may be useful in arranging such a shop. The whole shop should have a north aspect and all strong light should be avoided; indeed it is better to make the light as subdued and as nearly constant as possible. This is important, because under our present method of working without the aid of pyrometers, the only means of regularly judging the heat is by means of the eye, and it is easier to estimate a heat color in a constant shadow than in a strong light.

The Process.—Having enumerated the equipment of a case-hardening plant, we may now proceed to consider the process as it is, or should be, carried out.

The carbonizer having been thoroughly dried and reduced to a fine powder, a layer of not less than 1½ inches in depth is placed in the hardening pot and well pressed down. Upon this are placed the articles to be hardened. Care must be taken to leave sufficient space all round each piece to prevent its touching the other or the walls of the pot; a space of 1½ inches should be sufficient. Another layer of carbonizer is then put in and well pressed down, taking care not to displace any of the articles already packed, continuing until the pot is nearly full, and then finishing off with another layer of 1½ inches at the top. The object in view must be to make the contents of the pot as compact as possible, consistent with a sufficiency of carbonizer in contact with the articles. The more solidly a pot is packed the more effectual is the exclusion of air. The lid is then put on, and the joint all round well luted with clay. By the time the proper number of pots have been filled, the furnace must have been raised steadily to the full working heat.

According to my experience the proper heat for case-hardening is 1,000 deg. C., or a full orange "heat color," and this should be maintained with great regularity throughout the operation. The length of time occupied in carbonizing is regulated by the depth of casing required, and indirectly by the dimensions of the article. To this I will return later.

At the close of the carbonizing period the pot is withdrawn from the furnace and placed in a dry place, where it is allowed to become quite cold. It is then opened, the articles taken out and brushed over to remove all adhering matter. If the pot has been properly packed and luted up the articles should be quite white, or at least have only a slight film or bloom of a deep blue color; the denser and more inclined to redness is the surface the more imperfect has been the packing and sealing of the pot.

The case-hardened articles are now placed in a muffle furnace and steadily raised to good cherry red (800 deg. C.), and then quenched in cold or tepid water or oil, according to the purpose of the articles required. They should remain in the cooling liquid until they are quite cold right through the body of the metal, thus completing the process.

Analysis of the Process.—Having already considered the essentials of a proper case-hardening shop and its equipment, it remains now to go more thoroughly into the different points which arise in connection with the process itself.

The carbonizer must be finely powdered. It is very necessary that there should be absolute contact between the surface to be case-hardened and the carbonizer; the larger the particles the more likely are there to be air spaces left, which result in uneven and irregular casing. For a similar reason a sufficient distance between the articles must be allowed, and all danger of contact with the pot guarded against.

I have said that the proper heat for case-hardening is a full orange color heat, or 1,000 deg. C.; but I may here qualify this by saying that the heat may, to some extent, be altered to suit the purpose in view. In order, however, to thoroughly understand and take advantage of this fact we must consider more fully the theory of the process. With this purpose in view we must first understand, so far as possible, the relations between carbon and iron in the cementation process, and, following this, the modification of it known as the case-hardening process.

Carbon and iron have strong affinity the one for the other, and when brought into contact at suitable temperatures a combination takes place in which certain carbides of iron are formed. The physical properties of iron are changed by this combination, hardness and tensile strength being raised in proportion to the amount of carbon absorbed. (By the term "iron" in this case we may understand iron or any steel capable of combination with carbon within the limits of the process.)

The object of the cementation process as carried out by the maker of crucible steel is to convert bars of commercially pure iron into steel containing from 0.80 to 1.5 per cent of carbon, and, so far as possible, for the resultant steel to be uniform in constitution right through the bar, while the case-hardener wishes to put only a skin or case of hard steel, leaving the center soft and tough. The quantity of carbon which can combine with iron is governed, first, by the temperature, and secondly, by the period of time the action endures. The absorption of the carbon commences when the steel reaches a low cherry-red heat

* Paper read before the Cycle Engineers' Institute, Birmingham.

(700 deg. C.); it begins, of course, at the outer surface and gradually spreads until the whole of the steel is carbonized. The length of time this requires depends upon the thickness of the metal being treated. The percentage of carbon absorbed is governed by the temperature, and although the increase of carbon is not in uniform proportion to the rising temperature throughout, it is perhaps sufficient for our present purpose to note that at 700 deg. C. iron, if completely saturated, can obtain no more than about 0.50 per cent carbon; at 900 deg. C., about 1.5 per cent carbon; and at 1,100 deg. C., about 2.5 per cent carbon. These results, however, are only obtained when the whole section of the iron has received all the carbon it is capable of absorbing at the given temperature, and is therefore in a state of equilibrium. From this, I think, you will see that if the process is stopped before the action is complete, the central parts of the iron must contain less carbon than the outside, and upon this fact the process of case-hardening is founded. As already stated, the object of case-hardening is to give certain articles a dead-hard surface, while yet retaining a very mild and soft center, thus uniting the maxima of hardness and of strength.

At this point we should consider the essentials of the material to be used. Briefly, I may say that iron has been almost entirely superseded by steel, both for cycle and most engineering purposes; but it is of great importance that the steel employed should be of such a nature that, combining sufficient purity with absolute regularity of composition and condition, it is capable of absorbing a uniform amount of carbon, and at the same time the body of the steel remaining in the soft core shall yield its highest results in tenacity and strength after it has passed through the process of case-hardening. From this point onward we have to bear in mind the fact that in all other treatment of steel we have only one steel to deal with at once; in case-hardening we really have to treat two steels, inseparably connected, but differing in composition, and to treat them in such a manner as to get the best results from both—that is, of course, the core of mild steel and the case of hard steel. In the case we require such a percentage of carbon as will yield a dead-hard surface when properly hardened, and in the core an extremely tough steel which will take a very severe bend without breaking.

First, then, we have to determine at what temperature we are to work the cementation part of the process, and to decide this there are several points to be strictly observed. (1) The carbon in the case must be about 80 per cent. (2) The case must be neither too thick nor too thin. (3) The temperature must not be so high as to overheat the mild center. (4) The core must be of the greatest possible strength.

Although I have given separate requirements, we must consider them altogether. A temperature of 1,000 deg. C., if continued to saturation, would yield a carbon percentage of about 2.5; but if interrupted at any stage short of saturation, the skin would contain less carbon, and the center still less, on account of the process of diffusion being still in progress. If we take two pieces of ⅝-inch diameter round mild steel, and heat one of them with a carbonizer at a cherry-red heat and the other at a bright orange heat for six hours, the first will be cased to a depth of about 1-32 inch, and the other to a depth of nearly 1-16 inch, while the amount of carbon taken up will be about 0.50 and 0.80 per cent, respectively. So that, so far as regards the hardness of the skin, the piece cased at the higher temperature gives the best result. From this we learn that a temperature of 1,000 deg. C. will give us sufficient hardness of case.

We have next to find which temperature has the least hurtful effect on the mild-steel core, and this can best be found by heating pieces of the mild steel at varying temperatures at and above the selected one for the same length of time, using lime or other inert substance in the pot instead of a carbonizing material, and afterward reheating and quenching in water. Suppose, for example, we take three pieces, heating at 1,000 deg., 1,300 deg., and 1,500 deg. C., or full orange, white, and bright white, respectively. We shall find that those at 1,300 deg. and 1,500 deg. break very short and have lost nearly all their original tenacity, while that at 1,000 deg. appears tougher and altogether stronger than before.

Having arrived at a knowledge of the right temperature, it remains now to inquire as to the length of time requisite to yield a sufficient depth of case; and although I can give you an average figure of the results I have obtained in my own experimental work, yet owing to slightly different methods of working and appliances, and also the variation in shape and dimension of the articles to be cased, the only reliable way of obtaining definite results is by trial and error. At a full orange heat a bracket cup of ordinary dimensions would in two hours be hardened 1-32 inch deep, and a bracket axle 11-16 inch diameter, in six hours would have a case 1-16 inch deep. From this it will be seen that the speed of penetration is not in exact proportion to the time of heating; this is most probably due to the fact that the outer surface being in direct contact with the carbonizer, first must become saturated, while each succeeding zone has to receive its carbon by diffusion—a slower process. I have said nothing as to the mode of counting the time, but from what I have already stated it will be clear that it will be correct to start counting from the moment when the pot reaches a bright red heat. But, provided the furnace can be relied on for regularity of heating, the time can be taken from putting in the pot, adding from thirty to forty-five minutes, according to the size of the pot.

Water Hardening.—We now arrive at that part of the process where a most important improvement has been made—I mean the final hardening by quenching in water. When, many years ago, I first took up the serious study of the case-hardening process I found great irregularity and consequent distrust of the process, and after many experiments was successful in finding a solution of the difficulty. At that time it was customary at the end of the carbonizing period to open the pot and fling the contents headlong into a tank of cold water. Here and there some of the more careful workers took each article separately, but direct from the pot, and plunged it into water. These latter obtained better results, but even they had a great deal of trouble in the way of breakages and want of regular hardness. Finding that axles taken singly from the pot and quenched were better than those quenched in bulk, and that if allowed to cool down to cherry red they were better still, an application of the old rule to harden on a rising heat led to the now established principle of allowing the pot and its contents to become quite cold, afterward reheating to cherry red and quenching with water. By this means we obtain a case of great hardness with a very tough core—that is, of course, provided a suitable steel is employed.

To understand the reason of this improved method of working we must remember that the exterior of the steel is now about 0.80 per cent carbon, and that steel of all kinds raised to and maintained at the high temperature employed for case-hardening will, unless subjected to mechanical work, show evidence of overheating, being very brittle and liable to easy fracture; and though quenched in water, and consequently hardened, the metal has little or no cohesion and readily wears away. Steel so hardened breaks with a very coarse crystalline fracture, in which the limits of the case are badly defined. It is known that when steel is gradually heated there is a certain point at which a great molecular change takes place, and that perfect hardness can only be obtained by quenching at this critical point. If quenching takes place below the critical temperature, the steel is not sufficiently hard; if above, though full hardness may be obtained, strength and tenacity are lost in part or completely, according as the critical temperature is exceeded by much or by little. This critical point lies between 750 deg. C. and 800 deg. C. or cherry-red color heat. It may be asked why it is not sufficient, when taking the article out of the pot, to allow it to cool down to cherry red and then quench it. To this I would answer that the high temperature has already created a coarsely crystalline condition in the steel, and that until it has become quite cold and has again been heated up to the critical temperature, a suitable molecular condition cannot be obtained. When steel is cooled, whether slowly or not, it bears in its structure a condition representative of the highest heat it was last subjected to. From this, I hope, it will be quite clear that in case-hardening, as in all other methods of hardening, the steel must be quenched on a rising heat. I may add that for certain purposes there is some advantage to be gained by quenching direct from the pot, if followed by reheating to cherry redness and again quenching; but this I will remark upon later.

Having, I hope, made clear the reason for complete cooling after carbonizing, followed by reheating for water-hardening, we may proceed to consider the proper manner of carrying this out. We must remember that the case-hardened article now consists of two kinds of steel, one being mild steel of a temper that will not harden in water, and the other capable of becoming glass-hard when properly heated and quenched. The critical points of the two steels are not, of course, the same, that of the hard steel being slightly lower than that of the soft steel. Therefore, bearing in mind my previous statement that to obtain complete hardness in the skin and the maximum of strength in the core, they must both be heated to their critical temperature before quenching. Now, as the critical points of the two are not identical, and as they must be raised at least up to those points, it follows that one of the steels will have to be heated considerably above its proper hardening point, or the other not heated sufficiently to reach its greatest tenacity. We have therefore to find which of the two will result in the least risk. If we heat the article to the critical point of the hard steel case we do not reach the critical point of the mild core; and, on the other hand, if we raise to the proper heat for the mild, we exceed that of the hard steel. As our object is to obtain hardness combined with strength, and as the strength lies almost entirely in the core, it follows that we must heat sufficiently to remove the coarse crystallization of the core, thus exceeding the critical point of the case; and in doing so, while we obtain very nearly the maximum hardness, we lose very little of the strength of the case and obtain the maximum strength of the core. I have gone rather fully into this point, and, it may be thought, without necessity, as the temperature is almost universally judged by the eye. But my object in doing so is to point out how important it is for the second heating to be sufficiently high to obtain the best result. The case-hardened steel as it comes from the pot cannot be rendered hard and strong without a sufficient second heating. If a test piece or finished article, when broken, shows a more or less coarsely granular fracture, and has the casing irregularly defined, it is an almost certain evidence that the second heating has not been sufficiently high; and this perhaps emphasizes the importance of using test pieces wherever possible.

From these remarks we shall see the importance of accuracy with respect to the temperature for reheating, a good cherry-red color being the correct one for all case-hardened work. Also, it is well to note that this reheating should, so far as possible, be rapidly performed, and once the article becomes uniformly of the right temperature, it should be immediately quenched in oil or water. Any prolonged soaking, even though it be at a proper heat, should be avoided, especially in articles like cups or cones, having to resist any lateral strains. The reason for this is as follows: A mild steel of proper composition, if subjected to prolonged heating just above its critical point, will develop a gray fibrous fracture having very marked laminations. Such a structure, though weaker than a finely crystalline one, will in the case of solid articles, such as bracket or pedal axles, which are subject to torsional or shearing strains, still have a sufficiently high safety limit; but if, on the other hand, the same structure exists in a cup or cone, the strain bears upon the steel in such a manner that, owing to the weakness of the laminations, it is unable to withstand the test. This gray or fibrous fracture, once developed, cannot be satisfactorily altered by any further heat treatment without deteriorating the case, and therefore precautions should be taken to see that it is avoided altogether.

Tempering.—It is sometimes desired that the hardness of the case be slightly tempered, but I cannot say anything in favor of it. The object of tempering is, generally speaking, not so much to reduce the hardness as to increase the strength; but we must bear in mind that the strength lies in the core of mild steel, and that even if the strength of this can be increased by tempering (which I doubt), you can only use the "temper color" given by the hard case as an indicator, and this can be no guide to the proper tempering heat of the core. Now, supposing that we are able to increase the strength of the mild core by tempering, it is highly probable that the proper tempering heat, instead of being represented by a "straw color," would be at least "dark blue" temper color, if not "visible red" heat color, and this, of course, would take away perhaps 50 per cent of the hardness of the case.

Stopping-off.—It is frequently required that axles and spindles shall be left more or less soft in the middle, in order to set or straighten them after hardening, and for this purpose it is usual to coat with clay such portions as require to be soft. Though often successful, this is by no means a certain measure to take, owing to the shrinkage of the clay when dry and heated. This shrinkage, though it may not be sufficient to allow the carbonizer to come in direct contact with the steel, allows the access of the carbonic-oxide gas which forms the atmosphere within the heated pot, and this gas is capable of case-hardening steel almost as completely as direct contact with carbon. Indeed, if it were not for several important practical difficulties, case-hardening by means of this gas alone would be an ideally perfect process. Knowing the risk of clay stopping, other means, more or less successful, have been tried; but to my mind, in all cases where soft portions are required, the only certain method is to leave the parts full size, and then, after case-hardening, but before water-hardening, to remove the superfluous metal by machining.

Extreme Hardness.—It may be desirable for special requirements to make extreme hardness the first consideration. In such cases the case-hardening heat may be raised to bright yellow (1,250 deg. C.), and then, at the end of the period, instead of allowing to become cold, take the pot from the furnace, and when the articles have cooled a full red heat, quench in water or oil, afterward reheating to full cherry and again quenching. Though by this method the absolute strength is much reduced a considerable increase of hardness is obtained.

Having discussed the process of case-hardening, it may be useful to consider briefly the principal faults which occur, and which may be detected by examination of the test pieces. As I have already stated, it is always of great importance to put a test piece in every pot, and to treat this in the same manner exactly as the articles being hardened. It is, of course, most useful to take one of the articles themselves, and use it as a test piece, and where possible this should be done. The tests to be applied come under the heads of "hardness" and of "strength." The hardness, in the absence of any special scientific tests, is proved by the use of the file; for this purpose a smooth saw file should be employed, and is a test too well known to need any repetition here. I may, however, remark that when using the file, and it appears as if the test piece were not fully hard, before deciding that this is really the fact, it is well to examine the file used, when it may be found that what were thought to be filings from the test piece are really the powdered teeth which have been forced away from the file. Sometimes the extreme surface is quite easily touched by the file, and the articles are declared to be soft; if, however, the filing is continued, a dead-hard surface is found beneath. This has been caused by the action of the air on the steel, either by incomplete sealing in the pot, or more probably by want of care in reheating.

If, for example, the muffle door has been left open, the air, acting on the heated steel, has decarburized the outer skin, leaving it soft. If articles having such a fault are afterward submitted to rather deep polishing or grinding, there will, of course, be little harm done.

The use of the file will also detect irregularity of hardness; but for this there is no remedy—prevention is the only cure.

Proceeding next to the examination of the test piece by fracture, we have first to judge its strength

by its resistance to impact, its tensional, torsional, or shearing capacity; but as a cycle works is not as a rule furnished with a testing laboratory, we need only consider such rough-and-ready tests as we may apply in the smith's shop. It is true that such tests are at best very crude (even when the results are compared one with another), consisting usually of blows by a hammer upon the test pieces, afterward judging either by the number of blows or the angle of bend as to whether the test piece is satisfactory or not. It should not, I think, even in a small works, be difficult to construct, at slight expense, a means of testing which would make it possible to obtain reliable results under fixed conditions. Thus, a constant weight falling from a constant height, if systematically employed, would make it possible to decide on the strength of all articles or test pieces of any given pattern, and thus create a standard. For this purpose would be required a couple of timber uprights with guiding strips, and, say, 12 feet high, together with beds of shapes varied to suit the different articles, and a series of weights proportioned to the size of the articles to be tested. A pawl catch placed 10 feet from the bed would then hold up the weight, which, when released, falling on the test piece, would give a constant blow, which could be repeated until either the article broke or was considered to be of sufficient strength.

Judging Fractures.—We have next to consider the fractures of the test pieces, and in doing this I may repeat that the structure of steel, as shown either in the fracture or the polished and etched section, contains a certain record of at least the last heat treatment through which it passed:

(*a*) Perfectly case-hardened steel will, when fractured, show a case of extremely fine white grain, and which is clearly defined and of very regular depth, while the core is finely granular and of a distinctly metallic luster.

(*b*) The case, instead of having a fine white dry appearance, is full of minute, brilliant specks, and is not so clearly defined. The core is much coarser and more sparkling, and the test piece would break easily, being more or less rotten. Such a fracture shows either that the article was quenched direct from the pot, or that, if heated a second time, it was not raised to a temperature sufficiently high to rearrange the structure caused by the high temperature of case-hardening.

(*c*) The outer zones of the case are coarser, as in (*b*), while the remainder, and also the core, are very little coarser than (*a*). This is the result of too high a temperature in reheating. An article having such a structure would, though of full hardness, wear into little pinholes and specks, and in certain articles of small dimensions very easily break.

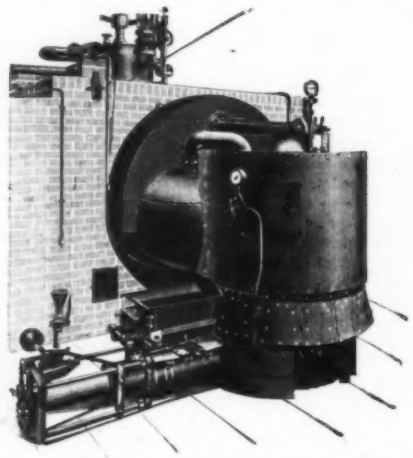
(*d*) The case appears as in (*b*), but the core is gray and fibrous, or when broken laterally shows very marked laminations. This is caused by too high and too long heating before quenching.

Such, then, are the principal faults which are to be detected by inspection of the fractures, but I must remind you that this list does not include any faults which are the result of defects in the steel employed. I have throughout taken it for granted that a good and reliable brand of steel is used. As a last general recommendation, I may say that the success of the process depends, first, on the use of pure material; and, secondly, having once established a proper system of hardening, absolute regularity in carrying it out.

SMOKELESS COMBUSTION AND ECONOMY OF FUEL.

By William Mayner.

There is a conviction in the technical world that all progress made during the last century, characterized as it is by the steam engine as its principal agent and promoter, has been unable to overcome two great drawbacks—the unnecessarily large consumption of



THE WEGENER MECHANICAL STOKER OF SMOKE CONSUMER.

fuel, or, more concisely stated, the waste of coal, and the production of thick, black smoke almost invariably accompanying the production of steam. These two imperfections stand in a certain relation to one another, the waste of coal being the cause of the smoke, but the smoke being only one of the consequences of the waste of coal, certainly one of its most prominent and disagreeable consequences, but by no means embracing the whole loss arising from uneconomical consumption of fuel. For there may be many cases of this kind, appearing less reprehensible because they only show a thin smoke, but which, nevertheless, are wasteful in a high degree, as shown by the unburned portions of coal escaping, in the form of soot, from the chimney.

At all events, smoke is the most obnoxious result of waste of coal, and if it can be shown that there is a possibility of attaining a perfect combustion of fuel, the abolition of smoke will be appreciated as a great blessing to mankind and as a factor of the highest utility. It is pretty generally conceded that the growing diminution in the number of sunshiny days and the increase of fogs in our large towns and manufacturing districts may be due to the smoke from factory and other chimneys. Moreover, it is an acknowledged fact that the vapor always present in the air, though generally without seriously affecting its transparency, when it comes in contact with particles of dust or soot in the atmosphere, attaches itself to them, producing water-bubbles, which, as a whole, constitute the fog.

Statistics show that, for example in London, the increase of foggy days is in direct proportion to the increased consumption of coal in that great metropolis, and that this is of a really terrible character, London being, for the greater part of the year, without sunshine. If such a state of things is allowed to continue, the health of the inhabitants of large towns and manufacturing centers must sustain a serious injury. It seems almost a crime to deprive large masses of the people of the blessing of sunshine—that source of physical and mental health. To speak frankly, it is a reproach to science that this evil has not yet been mastered and that for years further efforts to abolish smoke and coal waste had apparently been abandoned.

The actual waste of coal is of such dimension that the best of our furnaces use only 70 to 72 per cent of the heat produced by the combustion of fuel; a great number of our furnaces do not exceed 55 to 65 per cent, and this quotation gets down to 45 to 55 per cent for the bulk of all furnaces of the world.

The loss is either in the form of unburned coal or soot, or in the form of hot air at a temperature of 250 to 400 deg. C., passing through the chimney, heating only what is not intended to be heated, the atmosphere. It will be understood that smoke is more the sign of existing coal-waste, than the extent of the waste itself. From the loss shown by the figures as above, smoke forms only 5 to 7 per cent, the chief part of the loss being represented by the heat escaping through the chimney.

Reflecting on the causes of this great waste of heat and energy in all the furnaces hitherto in use, we find that they are of twofold character. A coal fire should never be disturbed and dampened, as is now the case, by opening the door of the fireplace and allowing cold air to enter or by throwing fresh coal on the layer of burning and live coal. The consequence in both cases is, that cold air and more air than necessary for the oxydizing process of the fuel, enters the furnace, with the effect that the gases, products of the distillation of coal in the layer of burning fuel, grow cooler while a surplus of air from outside is brought to a high temperature.

The ill effect of this is double. On the one hand, the heavy hydro-carbon gases just developed from the coal and ready to be burned to vapor and carbonic acid, are cooled down below their burning temperature, with the effect that they are dissociated, giving free a large part of their carbon in the form of soot-flakes, which escape through the chimney. On the other hand, a quantity of not wanted air is uselessly heated, but together with the lighter hydro-carbonic gases not brought to the temperature which the heating gases could have if they were the products of regular combustion of heavy hydro-carbonic gases and carbonic-oxide gas.

It is clear from this consideration of the processes going on in every furnace which is stoked and cleaned in the ordinary existing manner, that heavy losses of heat are inevitable both by the relapse of gases into carbon and by the lower temperature, which is the result of imperfect combustion. It is further evident that the latter cause of the losses, as it represents the sum of the alteration produced in the furnace by allowing the cold air to enter, must form the larger part of the losses. There are no other than these causes just explained which prohibit a rational and normal combustion of coal.

It is the undisputed merit of the German engineer, Charles Wegener, of Charlottenburg, near Berlin, to have clearly recognized the only existing impediments to a progressive step of the highest importance, one promising great economy, and also to have shown the means how to realize this saving with full certainty of success. His furnace represents in fact a grate which is entirely free from those drawbacks inevitable up to the present time. There is no door in Wegener's furnace, and there is a mode of continual, uninterrupted feeding of the layer of live coal with fresh fuel, subjected to a preliminary heating, and which is not thrown above the layer, but fed underneath.

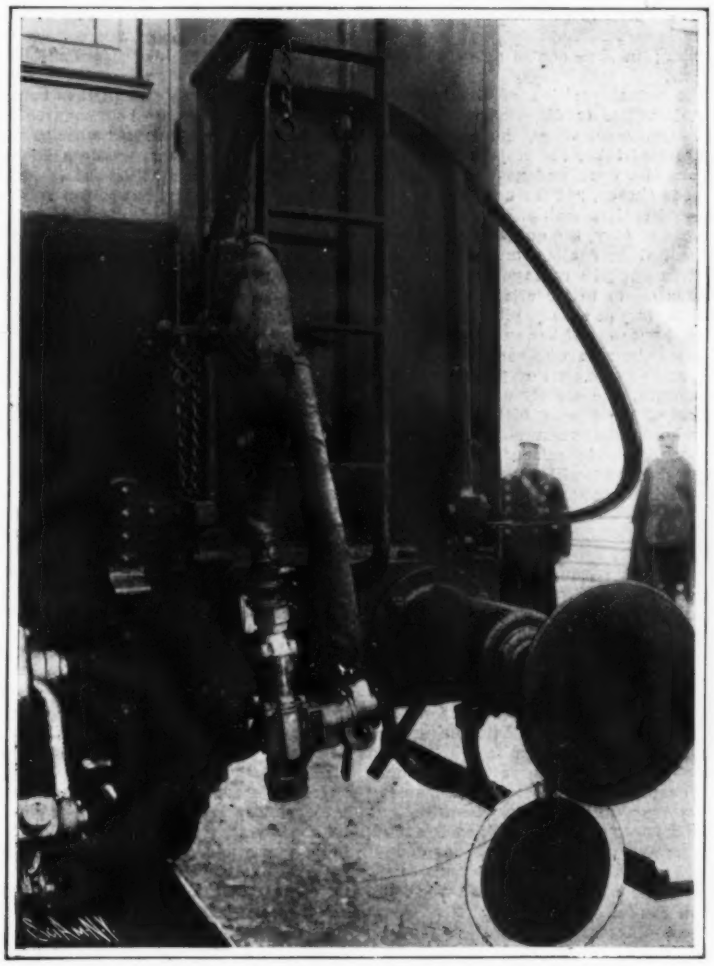
The effect of this contrivance is not only a completely smokeless combusion of all sorts of fuel, especially of soft coal, but an economy, which has been proven by various tests and in long periods of use under large boilers—as exceeding 20 per cent compared with all other systems used up to now.

This economy can, moreover, be theoretically proven as necessarily arising from the Wegener furnace by the chemical composition of the heating gases escaping from the chimney. They contain 17½ to 18 per cent of carbonic acid, no oxide of carbon, no hydrocarbonic gases, only traces of oxygen (as a testimony that there is no noticeable surplus of air), and such quantity of vapor as answers to a perfect oxidation of the fuel. Consequently the normal combustion is attained, and it is merely a question of suitable boilers to use the temperature of 1,750 deg. C., produced by this combustion, that the least possible quantity of heat escapes into the air. The inventor is working on the design of such a boiler at the present time.

The furnace consists of a combustion chamber of brick work, in which a pipe is arranged for feeding in the fuel. This pipe forms a knee, on the horizontal part of which a hopper is arranged with a slide for filling the pipe with fuel, and at the end of this part of the feeding pipe is the contrivance for introducing the fuel into the combustion chamber. It consists of a piston, capable of being moved to and fro, inside the pipe, and having attached to it a tube for a screw-spindle, which rotates in a bearing-block. The said spindle is guided in the tube by a ring at its extremity. At the end of the tube is a guiding head with three side blocks operated by a ring with eccentric grooves in such a manner that the blocks, the inner ends of

WEGENER APPARATUS FITTED TO A BATTERY OF BOILERS IN BERLIN.

which are provided with screw threads, are thrown in or out of gear with the screw spindle. Attached to the ring is a reversing lever provided with counterweights, which lever in the two extreme positions of the piston strikes against oblique stops respectively, whereby the ring is turned and the slide block brought in or out of engagement with the screw spindle. The



THE ELECTRIC-PNEUMATIC BRAKE VALVE ON CAR.

rotation of the screw spindle is effected in the following way: The shaft of the fan carries a worm wheel, which, by a spur wheel and connecting rod, imparts to the other rod provided at its extremity with a projection and sliding on the surface of the bearing block, a reciprocating movement. The screw spindle is fitted with a ratchet wheel, which is rotated by a lever with a pawl, the end of which lever slides on the second rod before mentioned. The projection of the rod striking against a roller at the end of the lever, brings the pawl into engagement with the ratchet-wheel, whereby this is turned. On the return movement of the second rod, the lever is brought back to its initial position by a spring. The piston is returned to its normal position by a counterweight as soon as the slide blocks are thrown out of gear with the screw spindle by the reversing lever.

The furnace is operated as follows: The pipe is filled with coal from the hopper in such a manner that a small heap is formed above the opening of the said pipe (its vertical part) in the combustion chamber. The small heap is covered with an easily-combustible material and then kindled. When the fire burns properly, the fan is set to work, care being taken to have only a slight blast at the start, the fan actuating at the same time the feeding device, whereby fresh fuel is fed underneath that which is already burning. The firing is controlled by regulating the fan, and the quantity of fuel fed by means of the feeding device described above. The slide hopper is connected to the guiding-head of the tube in such a manner that the slide is withdrawn and the hopper opened as soon as the piston has passed the opening of the hopper on its return journey.

It is seen from the above description that the fuel so introduced is subjected to a preliminary heating from above and from the walls of the vertical part of the pipe through which it has to pass.

The combustion chamber contains a cone-shaped grate, forming a round slope surrounding the vertical part of the pipe, which consequently exactly follows the axis of the cone. A supply of air under pressure is not necessary, as the combustion can be maintained by the draft of the chimney only and by air which is admitted from below into the combustion chamber through the spaces of the grate and from a system of short movable casings surrounding the cone grate. The parts composing this casing each correspond with one of the twenty or thirty parts of the grate, which, together, form the mantle of the cone and can be removed, one after another, in the case of stirring the fire and freeing the grate from slag.

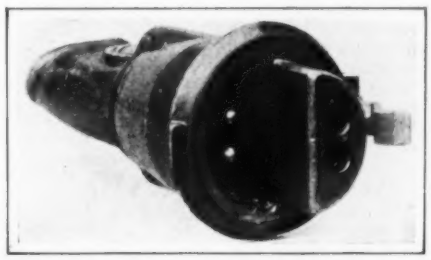
It appears from this description that the Wegener furnace fully answers the requirements for perfect combustion, by preventing every possibility of cooling and disturbing the fire and by establishing a continual, uninterrupted feeding with small quantities of fuel previously heated. It is further a most remarkable feature of this furnace that it works entirely automatically, allowing an increase or decrease in the speed of feeding by simply turning a handle controlling the feeding apparatus. The furnace is practically smokeless and only through abuse or improper handling is the appearance of smoke possible.

Preparation of Wood Stains.—Wood stains are manufactured in England on a large scale and exported to many countries, so that it will be of interest to know their composition. While on the continent mere dyestuffs are used, which, penetrating into the wood, color it, they employ wood stains in England which at the same time contain a binding agent that becomes insoluble in water on drying, thus insuring a faultless fixation in the wood. For a binder a shellac-borax solution prepared by boiling is made use of. The dyestuffs are then added to the hot solution and heated with it until dissolved. Next, the solution is allowed to cool and strained through linen. The finished stain is filled in bottles in which it will keep, tightly closed, for years, without changing.

NEW GERMAN ELECTRICALLY CONTROLLED AIR-BRAKE SYSTEM.*

By FRANK C. PERKINS.

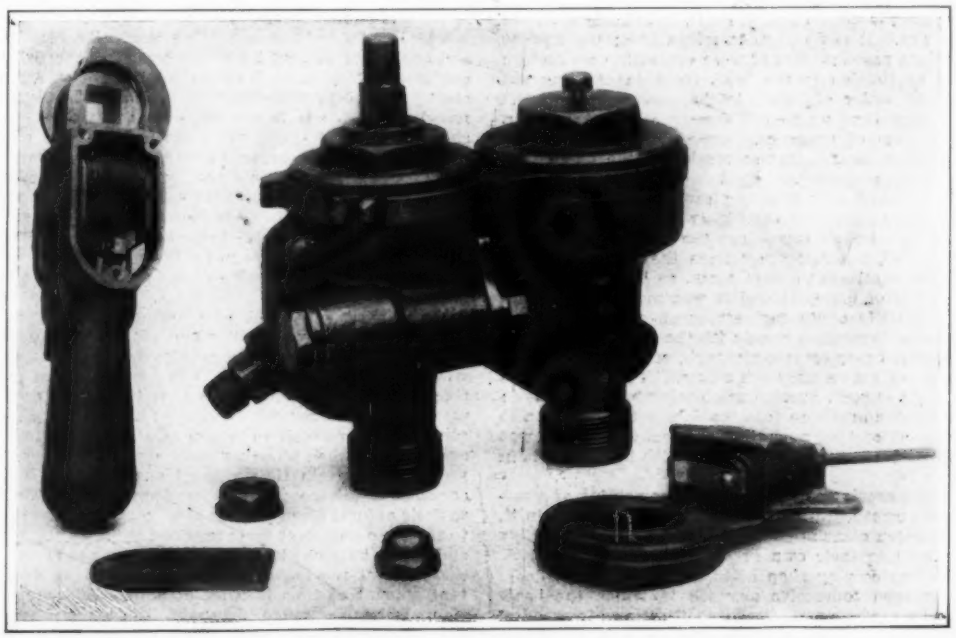
A NEW system of air brake has recently been brought out in Berlin, Germany, by the Siemens & Halske Actien Gesellschaft which are electrically controlled and are said to have advantages over the electric brakes, pneumatic brakes, and mechanical brakes now in operation on steam railways and electric lines. The accompanying illustrations and drawings show



PART OF A COUPLING.

CONNECTING CABLE.

the details of construction, electrical connections, and arrangement which has been designed as an improvement over the Westinghouse brake, the action of which is said to be too slow, causing the rear cars to be jerked and jarred against those in front, as well as to obviate other difficulties. The new electro-pneumatic brake constructed by the Siemens-Schuckert Works has electrically-operated valves between the cylinders of the brakes and the main pipes, these valves being opened and causing the braking to take place as soon as a current has been sent through the electro-magnets. An operating switch is interlocked with the driver's brake cock, similar devices being placed in the cars so that any passenger, or conductor, can stop the train in an emergency. The accompanying illustrations show the switch, which is controlled by a piston, a spring being utilized on one side and the air pressure of the pipe on the other. This switch, which closes the circuit, is arranged at the end of the train, the brakes being placed in action as soon as the pressure of the main conduit falls. This system includes an arrangement which acts in such a way as to set the brakes in case there is a short circuit or the electric circuit is broken from any cause whatever. There is mounted on the brake valve a switch which acts in such a manner that the valve is not moved at all with the exception of the handle, the same handle being designed to operate the connector



LOCOMOTIVE MANIPULATING SWITCH AND VALVE OF ELECTRICALLY CONTROLLED BRAKE.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

as well as the valve. The handle is placed in the closing or lower position at first and then continues in its movement alone, operating the brake as soon as the electric contact has been established. All of the brakes are acted upon simultaneously as soon as the current traverses the valve, the current being switched off as soon as the handle is released, a spring returning it to its former position. This new type of electrically-controlled pneumatic brake is being tried on the large European railway and it is stated that by the use of this system the braking of a train is rendered not only absolutely certain but causes a gradual and gentle braking action.

The current for operating the electric valve is supplied by a storage battery of twenty cells on the tender, the manipulating valve and switch being mounted on the locomotive, as shown in the accompanying drawing. It is claimed with this system of electro-pneumatic braking that the last car of a train has its brakes set within from two to three seconds from the time the switch and valve is manipulated on the locomotive.

THE GENTLE ART OF HUSTLING.

By FRANK FIELDEN.

"MUST be a good hustler." What an ejaculation of scorn and contempt would the average British engineering shop or machinist foreman a few years ago have uttered on seeing this sentence interwoven in the "Wanted" column of an engineering journal or daily newspaper. Even now when so much of the Americanizing methods have been introduced into many of our works it carried an ill-odor with it to our more or less tender dictionary palate. When our young mechanic or engineer first sees the word, he pictures some huge monster of physical inhumanity, whose possession of brute force far outweighs his mental capacity or attainments, let loose in a works where each employe is in daily or hourly fear of coming under the terrifying ban of one who rules by curses if not by blows, where reason is entirely absent, where mistakes or blunders are never forgiven, and where brute force always triumphs over and effaces any finer feelings that a man may possess. The dictionary meaning of the term tends to this exaggerated idea. To hustle is "to crowd upon so as to shove about roughly; to push or elbow out or about rudely; to jostle,"—*vide* our standard dictionaries. But what a mistaken idea this is of a successful hustler! For the wrong application of this term we must condemn our American brethren, for in this, as in many other words, an exaggerated term is used by them where a more modest and strictly truthful word could have been chosen. While one must admit the very arbitrary and dangerous ground walked on when criticising the application of words or terms, it is important that false ideas should not be formed. The successful hustler may be mild or rough in manner; he may be physically a giant—very often he is the opposite; he may choose his words with the highest refinement of culture, or he may besprinkle them with coarse expletives. There are scores—nay, hundreds, if not thousands—of successful hustlers, of whom probably not two are exactly alike in disposition or in method. The question then comes, "What constitutes a good hustler as the word is ordinarily employed and understood in engineering circles?" and though it admits of several answers, possibly the truth will be spoken by saying that the successful hustler is he who gets the best out of the men and materials under his charge.

Hustling is not an end in itself, but simply a means to an end. It is no new American idea; the ancient Egyptians practiced it, and were evidently very zealous in its application to the brick trade in carrying out Pharoah's order of "More bricks, cheaper materials." From that time up to the present it has been in a varied state of existence. Certainly, as competition has become keener, just so much has the hustler become more necessary. Although our engineering forefathers were not invariably strangers to the practice, yet it had not become the highly-organized institution that it now is. In those days the engineer very often was judged, not altogether from the time it took to complete a certain piece of work, as he was from his versatility of practice; and it was more of a case of the possibility of an engineer or an engineering firm being able to tackle a certain job than it was the actual number of hours occupied, though, of course, value for money was not an unknown axiom. The reason of this is not far to seek. Specialization was almost unknown; very often no reliable data could be got together as to the actual cost of a similar previous job, if, as was seldom the case, an exactly similar job had really been done.

An engineering artisan had to be something of a carpenter, mason, millwright, boiler-maker, machinist, and a dozen other allied trades, which are now rigidly split up into their own branches.

The engineering shop of those days held its doors widely open to receive any job in which the baser metals played a part. Consequently it was impracticable to state a time to a fine limit in which a certain job could be completed. Again, the craftsman had more inclination for some branch or branches than others, and a very satisfactory accomplishment in these had to be set against the misfortunes he might be subjected to, and the slowness of completion in others, yet it was essential that he should be employed on any and every job that turned up.

Contrast this with present-day practice in standardized and repetition works, where the times for any and every job are booked and tabulated to the exact minute; where the same patterns have been in use for years; where methods have been adopted for preventing almost all possibility of error or miscalculation; where the speed and feed of every tool is known and adhered to; where the artisan is given, not an approximate possible time that he might be able to keep to, but a definite time that the work has actually taken before; where each man is kept to some division or subdivision of operations week in and week out, and, in some cases, year in and year out. Contrast past practice with this, and it needs no apology for the attendant modern methods of supervision; in fact, one is an outgrowth of the other.

What, then, is the actual position of the modern hustler? Naturally, it varies in different works. In some shops, or, rather, in most shops, the foreman in charge of each department takes the responsibility, in addition to giving out the work and general supervision. Very often he is chosen, not for any mental attainments, or even good craftsmanship, but because he possesses a strict sense of duty, the qualities of a good disciplinarian, methodical in routine, and withal the appetite for production and the courage necessary to spur even good hands on to better attainments. He must forever keep things up at concert pitch. He must be able to quickly weed out the shirker and make-belief, and install in his place the man who can get through his work, do it well, and show a good output. The man who will scamp his work, and merely aim at getting it through, regardless of the quality of his workmanship; the dodger who works when stood over and slackens off when vigilance is relaxed; the honest though misguided worker who will persist in putting unnecessary finish on his work; he who cannot discriminate where extreme accuracy is essential, and where a rough approximation only is required—these are a few who must be either drilled and re-drilled into shape, or, being past redemption, transplanted to a more congenial atmosphere.

The merely theoretically clever engineer, or even clever practical engineer, is not by this virtue alone a successful hustler, or manager, though these are useful qualifications. The man who will not be bamboozled when a workman grumbles at his tools rather than get the best he can out of them; who also will insist on receiving from other departments the necessary supplies so as to be able to always feed his men; who will suggest a slight alteration in patterns, whereby work can be cut out; who knows what each man is engaged on and how long he is likely to be with it; and who has always a job in hand awaiting each workman under his charge; and who possesses withal an unquenchable enthusiasm to improve the output each week, or month, or quarter. This is the man who makes one type of successful hustler.

Different shops and different districts demand different methods and degrees of hustling. Where a certain shop or district has been accustomed to very rigid rules; where leakages have been closely scrutinized, and where the employes have been submitted to close examination with respect to their individual outputs, and where the men have grown up accustomed to criticism in case of laxity, and have been governed by the law of the survival of the fittest, innovations may be introduced which would be disastrous in other shops, where each man has been allowed his own time and methods; where suggestions from occasional new hands for quicker dispatch have been ignored or repelled at the hands of his foreman or manager, and where youth has been assiduously taught that he is greatest who can retain his berth while doing the minimum of work in the maximum of time.

Happily, these ideas are being gradually dispelled, and one is not without hope that some day the British engineer artisan will not only pride himself on a first-class job (and in whatever shop or district he is to be found this pride is inculcated, even among the black sheep of the flock), but will come to learn that quick dispatch means expansive, not congested, markets.

Scores of examples could be given of the accomplishments achieved by the modern hustler which more than justify his existence. Agricultural machinery, textile machinery, machine-tools—these and a host of others owe their widespread use not a little to the man who, in his own particular sphere, was able to reduce the cost to the level of the public purse.

He is most successful who, being something of a student of human nature, can suit his methods to each individual case. Some men require a little persuasion, which, if properly used, need not cause a loss of prestige on the part of him who uses it. More forcible methods have to be used with some hands. They need something more positive to aim at. Their best results are obtained when told they must accomplish a certain result in a certain time without any excuses. These are some of the most difficult hands to manage. Owing to their natural disposition in some cases, and in others to the loose nature of their previous training and oversight, they have an almost natural aptitude to run their machines at too low a speed, or to spend an exorbitant amount of time in a lot of unnecessary preparation. Unless prevented, they will discuss the *pros* and *cons* of the job with their fellow-workmen; they will walk around the job, get a large amount of unnecessary tools and tackle about them, and in other ways consume a great deal of their own and other people's time in totally wasteful preliminaries. They are not exactly lazy; they would be indignant if such a suggestion were made, and not without some amount of reason. They are guilty of misplaced energy—a common cause of a great deal of lost time and wasted efforts in nearly all our shops. Attempt to show them by discussion or argument that they are doing things which are superfluous, and they will waste your time as well as theirs. Tell them the job must be done in a set time, and they do it, and their own conviction is secured where hours of argument would be lost on them.

In some shops the competitive spirit is largely fostered, and a great deal of success has been attained thereby. To be sure, the trades unions have an extra long coffin-nail for this crime. Yet in many union shops it is bearing good fruits, and must do if encouraged by the hustler. Healthy competition between one man and another has aroused the natural instinct more in some cases than anything else would have done. Union or no union, he is a proud man who after weeks and months of continuous striving has honestly managed to go one better than the best man in his department; and though his victory is not hailed with manifest delight by his fellow-men, yet deep down in their hearts they have a wholesome respect and admiration for him. Not only individually, but collectively has this natural instinct been developed. One department will boast of its accomplishments as compared with another department in the same works. One works will compare itself with another works in the same district. Right along the line this goes on, until we have nation comparing notes with nation.

Very often a reminder of what has previously been accomplished by a man will spur him to attain that for which abuse would be fatal.

Encouragement is effected by a judicious recognition of a good attainment. We are all human, and the best of us is helped by a cheerful word or sign of appreciation. Nothing kills ambition for the best and highest attainments so much as lack of appreciation. A foreman or manager who will not trouble himself about the individual results of the men under his charge is not only useless in getting the backslider up to the mark, but is a positive check on those (the cream of our artisans) who are willing and even anxious to beat past efforts and results. It is quite possible to go to extremes either way. To fawn on a man and exaggerate his qualifications to him simply results in a loss of prestige and contempt; and unless tact is shown it is quite possible to defeat the end in view.

A method which is getting rather popular these days is for the works manager or general manager to fix a delivery time by which the work must be finished and delivered, whether the customer is pressing for immediate delivery or is granting a liberal time allowance. The superintendent or head foreman is taken into confidence, and the earliest possible time of delivery is settled upon, and the departmental foreman is then instructed to keep to that date. He, in his turn, informs his hands that the particular engine, machine, or motor must be completed by that date, and very often sees that it is done in the time stated; whereas, if the delivery time was indefinite, an appreciable amount of time would be lost through the men having no definite object to aim at.

This principle has been found to be very successful where other systems have failed in their ultimate object. It is applicable not to just one or two isolated examples as some of the hustling methods are, but can be successfully applied to most, if not all the varied branches of engineering. It gives, where sometimes needed, the foreman or hustler an acceptable *locus standi*. Instead of a man saying mentally "Why should I increase my output, and do more work merely to put more money into my employer's pocket?" he is led to say "I shall have to lay in for all I'm worth, otherwise the job won't be done by the time the delivery is due; resulting possibly in the order being cancelled, and at the least displeasing the customer and influencing other repeat orders adversely." The last few years have seen a great advance in the appreciation of our employes of the fact than an employer's interest and their own are more or less mutual. The long period of depression that the engineering trade has been suffering from has taught our men, better than anything else could have done, that if the employer suffers, then the employes are bound to suffer also.

The firms who can afford to fold their arms and say "We have now got the maximum results from our men and machines. Let us rest content, and cease troubling about better results," are very few and far between, and their number will grow less. How often has it happened in the past that businesses with names to conjure with have eventually been lost sight of, and have passed out of existence, the cause of their banishment being the competition brought to bear by hustling rivals. There is no finality in the matter of ingeniously-designed tools and the amount and diversity of their production, and there can be no finality to the results of a skillful and tactful government of the impelling forces of our leaders. The man who is so thoroughly satisfied with his own or his servant's present accomplishment as to suffer too much relaxation will, unless he is fortunate, have difficulty in so thoroughly satisfying his creditors; while he who moves with the times, and suffers no lagging, is he whom, for want of a better term, the world designates a hustler.

Any method, then, or any machine which helps to keep us abreast of the times is, more or less, a hustling device. In fact, one is tempted to say (with apologies): "All the world's a hustle, and all the (successful) men and women merely hustlers." It is, perhaps, unnecessary to say, then, that mere brute force is not an ideal hustling method. Neither is he the successful hustler who runs at breakneck speed without looking for obstacles, and is therefore tripped up with the slightest stumbling-block.

Piece-work and bonus systems are examples of hustling, and are typical of scores of other systems and methods, the principle underlying them being to con-

stantly attempt to improve on past performances, and thereby get a greater reward; and emphasis needs to be laid on this latter point. Our British employers have one very common failing as compared with their American brethren. The axiom which a large number seem to accept is that a comparatively big wage is not economy; and while they are quite willing that American or any other modern methods should be introduced, they give very little thought to the accompanying factors. A large outlay on a machine-tool is considered both justifiable and commendable if its results bring increased economy of production; but mention a large outlay of salaries, and although the results may be—as they very often actually are—ten or fifty times greater than those from the tool, our engineering principals lose interest. While in many cases the fact that one's reputation as a good hustler does not prejudice an overseer or manager in the eyes of the men, it often happens that he is the object of a great deal of animus. The relative conditions of the United States and Great Britain are vastly different. We are naturally and intuitively slower to accept changes and alter our methods or increase our pace than the born Yankee, and the feeling that it is somewhat *infra dig.* for a trained engineer to hustle is one which is possessed to a greater extent than is generally admitted.

Certainly, the merely shop-policeman type of hustler, with bounce in place of brains, would receive a very short shift over here compared with the toleration exhibited in the States. There can be no doubt that the qualifications required in our general engineering works, where a first-class, all-round, practical training must go hand-in-hand with the necessary amount of tact or push, are greater than those required in the average Yankee shop, and yet the salaries paid there to the principal superintendents are beyond comparison with those of a number of our British works, where the inside manager is put on the same rate as the chief clerk or cashier. The fact that so many of the American shops are managed by Britishers is sufficient proof that hustling can be successfully done when the results are sufficiently appreciated.

There are several reasons why the Yankee has been able to set the pace, and that hustling has become such a *sine quâ non* of his engineering attainments. The climate, the speculative character of the people, the specialization which he has carried to such a large extent—these and many others are the reasons for his present position of hustling and quick-delivery specialist. His works are not so old as ours, consequently his tools are more modern, run quicker, and all the accompanying factors are arranged to facilitate and harmonize. He runs his cranes at a quicker speed; his hoists are as speedy again as ours; the drawing-office staff are hustled, the clerks are hustled, the typists, and even the ubiquitous office-boy is infested by the universal spirit surrounding his works. Small wonder, then, that when one of our British-trained engineers gets into the American shop, he soon forgets the old conservative notion that the greater his output the less chance of work for his mate. That the lesson is quickly learned is proved by the fact that by his well-balanced judgment he so soon assumes the reins of management.

Our surroundings have much to answer for in our present difficulty of successfully attaining the Yankee standard of hustling. The mere fact of speeding a traveling-crane, or replacing an old type by a modern make, has been the means of greatly assisting a hustle. A well-managed stores, where a minimum of red-tape, time-wasting, exasperating preliminaries are required in getting materials delivered into the works, is another very useful requisite. Quick means of communication between one department and another, a good stock of tools always on hand and kept in good repair, the adoption of those labor-saving devices which are most applicable to the particular class of work dealt with—these are all great helps to the hustler.

An instance illustrating the difficulty of the hustler with respect to the importance of the above points came under the writer's notice some time ago. A lathe under the charge of a hustler was, in his opinion, being run at too slow a speed. The belt was put on the next faster speed, and began to slip. The belt-repairer was sent for, and he tightened it up. The machine was started up, and the belt broke (it was rather an old one). Upon applying to the stores for a new piece to either repair or replace the old one, the hustler was told there was none in stock, and it would take two days to get a new length. On the grounds of economy (!) stock was never kept up in belting, although there were dozens of machines on which it was employed. All this time the machine-man, who certainly required hustling, was casting those voluminous glances round to his fellow-workmen which, when seen, are so guaranteed to raise the ire of a hustler and discourage him. The result was that the belt had to be put back on the old speed until such time as the new one could arrive, leaving the turner, for the time being, in the position of victor in the argument. This is only one, and not the best, of these instances which crop up continually, and make the life of a hustler far from being a happy one.

To sum up, then, the successful hustler for a general engineering works must possess more than the average amount of brains, must be strong, both physically and mentally, possessed of indomitable perseverance, able to suit his methods to the class of men he has to deal with, and must have a knowledge of the ultimate requirements of the production he is engaged on and the uses to which it will be put. He should be possessed of great breadth of mind, and should keep himself thoroughly posted up in machine-tool developments and practice, and should possess withal an insatiable desire for an ever-increasing and efficient output.

Enough has been said, perhaps, to justify the existence of what has been spoken of as a brutal curse, but which, when judged fairly, and all the circumstances considered, will prove a useful institution in helping us to maintain our position in the front rank of the engineering world, to wit, the hustler.—Engineering.

THE ORIGIN OF COAL AND OF CARBONATED SPRING WATERS.

By PROF. OTTO N. WITT.

AMONG the most interesting of scientific problems is that of the origin of the fossil fuels—peat, brown coal, bituminous coal, and anthracite. Scientists are now unanimous in the opinion that all these different substances are results of one and the same process, products of an exceedingly slow dry distillation, continued for thousands, even millions of years, of organic compounds which have been shut off from contact with the air and are being gradually transformed, according to perfectly definite laws, under the influence of the energy inherent in the earth's substance.

The great fundamental principle of all dry distillation, whether it occurs naturally or is arbitrarily induced by man, is this: The energy expended upon every organic substance is employed in breaking up the molecules of the substance by successive stages, in each of which two or more dissimilar products of decomposition are formed. In addition to products which are less stable than the original substance there are always produced others which oppose greater resistance to the action of extraneous energy or, in other words, are less affected by heat, in which form this energy is nearly always manifested.

Take an organic substance of the simplest type, a hydrocarbon. This, when subjected to dry distillation of any kind, always separates into two substances, one richer in hydrogen, and therefore more volatile, the other poorer in hydrogen, or richer in carbon. Of all elements carbon is one of the most resistant to heat, and hydrogen one of the most volatile. The various combinations of the two have properties intermediate between those of their components, and they resemble either component more or less closely in proportion to the quantity of it which they contain. Methane, or marsh gas, which of all hydrocarbons contains the greatest proportion of hydrogen, is a difficultly condensible gas like hydrogen itself, while chrysene and picene, which contain the greatest proportions of carbon, vaporize only at a red heat. But even these terminal members of the long series of hydrocarbons are affected, like all the intermediate members, by dry distillation. Both methane and picene are decomposed by exposure to a sufficiently high temperature.

Not until the elements themselves, free hydrogen and free carbon, appear as products of dissociation does the energy applied in the form of heat lose its power and the dry distillation come to an end. But until this condition of stability is reached the process goes on irresistibly. Each successive product of decomposition is itself decomposed in turn, unless it finds opportunity of escape from the influence of the source of energy, and thus there occurs distillation within distillation, leading usually to results of extremely complex character.

It is true that this complexity would disappear if we permitted the process to go on to its end. But we human beings cannot wait through the ages that Nature finds necessary for her operations. We break into her laboratories, the coal measures and deposits of lignite, and slowly learn to understand the nature and connection of the unfinished products which we there find mingled together. From the composition of the fossil fuels, from their percentage of carbon, which far exceeds that of fresh vegetable substances, we learn that we have here to do with those products of decomposition that are rich in carbon; and in the marsh gas, which escapes from every fissure of the coal seams, and is so formidable a source of danger to the miner, we recognize the other and more volatile portion, richer in hydrogen and poorer in carbon, of the products of dry distillation.

All this is an old story which, expressed more or less clearly, may be read in any text book of chemistry or geology. It is the purpose of the compilers of such books to give their readers an idea of the process of formation of the fossil fuels and to point out the connection between this process of nature and those instituted by man either in burning these fuels or in subjecting them to systematic dry distillation.

But in no such book have I found any mention of the fact that the process of decay and carbonization which take place in the interior of the earth involve, in addition to dry distillation, another regular phenomenon of very great importance in the economy of nature, namely, internal combustion.

The raw material which is elaborated by nature in her subterranean workshops does not consist of hydrocarbons, which can only be split up and dissociated by the energy applied; but of substances, partly animal but chiefly vegetable, which contain oxygen and nitrogen as integral parts, in addition to carbon and hydrogen. Nitrogen is a never-failing constituent of the protoplasm that was the vehicle of the life in which these substances originated. Most abundant, however, are starch and cellulose, manufactured by protoplasm out of inorganic materials, and containing no nitrogen, but a large amount of oxygen. Nearly half the weight of cellulose, for example, consists of oxygen. What becomes of this oxygen, when material consisting almost entirely of cellulose, such as the trunks of lepidodendra and sigillaria which form part of the coal deposits, is subjected to dry distillation?

One thing is certain, that in the process of coal formation the oxygen gradually disappears. While fresh dry wood contains nearly as much oxygen as the cellulose of which it mainly consists, the proportion of oxygen in fossil fuels of vegetable origin diminishes in proportion to their age, that is, to the degree to which the carbonizing process has been carried. It is smaller in brown coal than in peat, still smaller in bituminous coal, and in anthracite it is expressed by a fraction of one per cent.

This disappearance of oxygen is due to an internal combustion, which goes on together with the dry distillation and which consumes a quantity of the elaborated raw material which is proportionate to its original richness in oxygen. The products of this internal combustion are carbon dioxide and water, substances of such common occurrence that their presence in the coal measures causes no surprise, and that we do not immediately suspect their connection with the process of coal formation. Coal is damp, but so is everything extracted from the bowels of the earth, and the quantity of water in some coal is so small that it can be detected only by chemical analysis. Carbon dioxide is a gas and escapes, with the marsh gas, through the mine shaft. The air of all rooms in which men and animals are employed contains carbon dioxide. Why should not the air pumped out of a coal mine contain it, also?

If, however, we wish to convince ourselves that internal combustion actually plays a part in the dry distillation of wood, we need only go into the works in which such distillation is effected artificially in the course of a few hours. The gases and vapors which escape from the retorts can not contain any accidental admixtures, but all their ingredients must have come from the wood with which the retorts were filled. Now, water and carbon dioxide are two of the chief products of the wood distilleries in point of quantity, though because of their worthlessness they are thrown away and regarded as useless by-products.

In the process of coal formation also they are by-products of no value to man, but they acquire immense importance in view of their copious production in the economy of nature, which knows not the meaning of worthlessness or superfluity.

In the carbon dioxide and water resulting from internal combustion, Nature, in the course of her work of decomposition and carbonization, gives back to life a large part of the material which she has temporarily withdrawn from vital circulation during the formation of the fossil fuels. Both water and carbon dioxide find their way back to daylight through the pores of the overlying strata, to be transformed again into living matter by the action of the sun's rays. Incidentally they perform another function by keeping the pores of the earth's strata always filled and thus excluding from subterranean coal seams the oxygen of the air, which might cause ordinary combustion.

It is not the result of chance that carbonated water bubbles from countless springs in the immediate vicinity of coal beds, for example, in the valleys of the Rhine and the Eger. The carbon dioxide which here escapes from the ground, partly as a gas and partly dissolved in the water of springs, is derived from the internal combustion of the vegetation of past ages buried deep within the earth.

But great accumulations of vegetable matter are not needed for the production of carbon dioxide and water in this way. All the sedimentary rocks are, or have been, impregnated with finely divided organic matter, which is subject to the transformations which I have described, and pours forth continual and inexhaustible streams of carbon dioxide and water. This fact seems to explain the origin of the carbon dioxide of certain geological formations, zechstein, for example.

Geologists make the great mistake of regarding almost all water which occurs in the earth's crust as seepage water, which has soaked through from above and is now on its way back to the surface. The eminent geologist Suess, of Vienna, first proved that the water of certain springs, including the hot springs of Carlsbad, is a product of direct, or ordinary, combustion in the interior of the earth. To these must be added a third variety of water, which is due to the internal combustion of buried organic matter and has never seen the light of day until it gushes from the earth in the form of springs. The quantity of such water may be sufficient to make it an important factor in the general economy of the earth's surface.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT.

IMPROVEMENTS IN THE INDIAN INDIGO INDUSTRY.

AT Dalsingh Serai laboratory some experiments have been carried on by Messrs. Bloxam, Leake and Finlow, the report of which has been published. Unfortunately, great difficulties had to be overcome owing to the unfurnished state and limited accommodation of the laboratory, but the results are said to give promise of greater success in the future. Messrs. Bloxham and Finlow have discovered a method of isolating pure indigotin both cheaply and in large quantities from the crude material, so much so that it is proposed to work it commercially, although the efficiency of the process is not yet exactly determined. More important still is the aid this discovery will possibly lend to further investigation of the indigo industry. The red coloring matter was also analyzed, with a result that much of it was found to be present in both the artificial and plant indigo, but one was, it is thought, not the same as "indirubin." Indigo

containing this red is of much higher value than that containing blue coloring matters only. Mr. Leake has tried to improve the indigo by a process of selection and has succeeded in so far as in certain experimental plots at Dalsingh Serai, the produce is as much as doubled since 1903. These laboratories are now under the Pusa Institute, and are used for the furtherance of everything affecting agriculture by original research. The results obtained under the old *régime* are favorable in themselves, but still greater successes may be expected when the government undertakes the work, and when the experimenters are not hampered by lack of means or accommodation.

CHEMICAL AFFINITY.*

By Sir Oliver J. Lodge, M.Sc., F.R.S., LL.D.

The attraction of opposite electric charges with a force inversely as the square of the distance between them, is a well-known and definite phenomenon; and though it is true that a good deal remains to be discovered concerning the nature and vehicle of the force, yet it may be taken as a fundamental starting-point for problems in physics and chemistry, just as gravitation can be taken as a starting-point for problems in astronomy, and cohesion for problems in engineering. The real nature of the force is known in none of these cases: perhaps rather more is known about the nature of electric force than about that of either of the others, and it has recently become a question whether cohesion cannot be explained in terms of residual or surplus electric attraction.

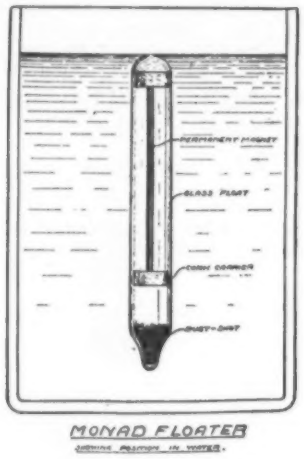


Fig. 0.—Monad float.

Fig. 1.—Monad.

Fig. 2 (X.)—Quite stable.

Fig. 3 (X.)—Stable, though with violent agitation it may break up into 2 and 1.

Fig. 4A (X.)—Stable, not at all easy to break up. If violently agitated, very liable to break into four single floaters, which in general combine first of all as 3 and 1. Sometimes, but more rarely, as two of Fig. 2, the whole combining later on to form 4A again.

Fig. 4B (VII.)—A fairly stable combination sometimes formed when Fig. 4A is broken up; it lasts some time, and then forms up into Fig. 4A. It is generally formed by the combination of two of Fig. 2, and if agitated tends to produce two of Fig. 2.

Fig. 4C (VIII.)—Stable, but with violent agitation breaks up in general into 2, 1, 1; sometimes into 3, 1; or 3, 1 is formed after breaking up from 2, 1, 1, by combination of 2 and 1, leaving 1 free. If a fourth of the same sign as the three, is brought up to Fig. 4C, one of the three already there at once sails away.

The three apparently distinct and quite certain kinds of force are electric, magnetic, and gravitational. For large masses of matter such as are dealt with in astronomy, gravitation overpowers every other kind of force and on a large scale may be said to dominate the material universe. But when dealing with small particles, or moderate masses of matter, chemical and electric and cohesive forces are much more energetic than gravitation. When a mass so large as the earth is concerned, it would be hard if the tenacity of a wire could not support a weight; and even with regard to the vastly greater mass of the sun, the pressure of its light and its electrical repulsion quite overpower its gravitative attraction on extremely small bodies in its neigborhood, such as apparently constitute the tail of a comet; and their apparent weight is therefore negative, so that they fly from it with prodigious rapidity, some of them producing auroral and magnetic disturbances as they fly with their electric charges into or past the atmosphere of the earth.

What has all this to do with chemistry? The force of chemical affinity, which binds atoms together in a molecule, has long been suspected to be purely electric;

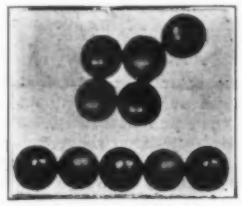


Fig. 5A (VIII.)—A stable combination; when the water is violently agitated it tends to break up into Fig. 2 and Fig. 3. These in turn in general combine to form Fig. 5B, though almost equally liable to form Fig. 5A.

Fig. 5B (VIII.) is a stable combination. On agitating the water it is hard to say what forms it is most likely to break up into, but Fig. 2, Fig. 1, Fig. 2 appears most likely; then comes Fig. 2, Fig. 3.

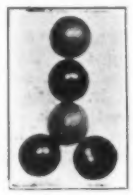


Fig. 5C (III.) is very unstable; it swings round to form Fig. 5A.

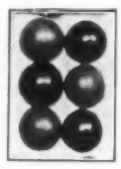


Fig. 6A (VIII.) is a stable combination. On agitating the water it can form Fig. 4A and Fig. 2, or sometimes two of Fig. 3. It may also open out into a circle, Fig. 6C, and close up at right angles, forming 6A again.

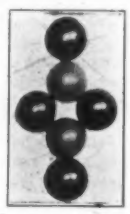


Fig. 6B (VI.)—Stable. On agitating the water it tends to break up into two groups of 3.

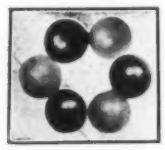


Fig. 6C (V.)—Fairly stable. On agitating the water it tends to change first of all into 6E, which changes into 6A. It may also break up into Fig. 4A and Fig. 2, these again combining to form Fig. 6A. It is also liable to break up into two sets of Fig. 3, or open out into a line 6D.

Fig. 6D (VI.)—Fairly stable. Tends to form Fig. 6A.

Fig. 6E (III.)—Not very stable. Tends to form Fig. 6A.

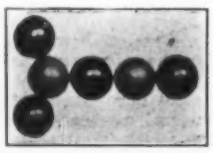


Fig. 6F (III.) is very unstable; it tends to form Fig. 6B.

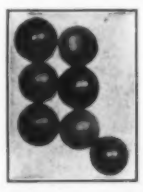


Fig. 7A (VII.)—Stable. Breaks up on agitating water into 3, 2, 2; also tends to open out into a line, 7B, which returns to Fig. 7A.

Fig. 7B (VI.)—Stable. The line may change into 7C, and from 7C into 7A.

Fig. 7C (VI.)—Stable. Tends to break up into Fig. 4A and Fig. 3.

Fig. 7D (V.)—Very weak combination, tending to break up into Fig. 4C and Fig. 3 on very moderate agitation of the water. It illustrates the breaking up better than any pattern yet dealt with.

Fig. 7E (VI.)—Moderately stable. Tends to change into 7C.

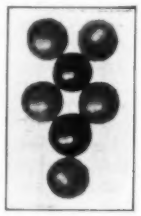


Fig. 7F (IV.) is a weak combination, changing into 7D.

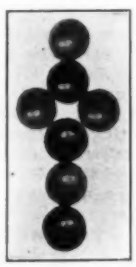


Fig. 7G (VI.)—Moderately stable, tending to form Fig. 7A.

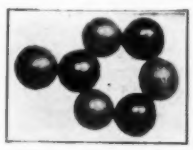


Fig. 7H (IV.)—Rather unstable, tending to form Fig. 7A.

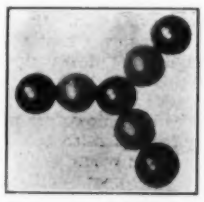


Fig. 7K (IV.)—Very unstable, tending to form Fig. 7A.

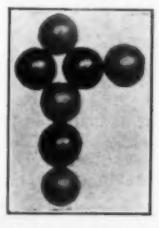


Fig. 7L (III.)—Very unstable indeed; tends to form Fig. 7A.

* Technics.

and just as electric attraction between bodies may be called chemical action at a distance, so the chemical affinity of one atom for another is simply electrical attraction at close quarters. Every atom of matter is liable to possess an electric charge—the so-called atomic charge—and in this condition it is an active ion. The great bulk of atoms are doubtless neutral; but some of them under certain conditions acquire

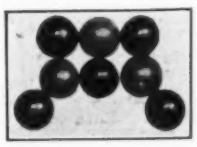


FIG. 8A (IX.)—Quite stable. Cannot say that it has any particular way of breaking up on agitating the water.

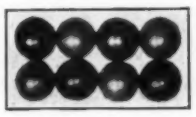


FIG. 8B (IX.)—Stable. No particular way of breaking up. Tends to go all to pieces with violent agitation.

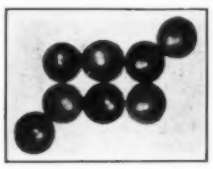


FIG. 8C (IX.)—Stable. On agitation has an inclination to form Figs. 2 and 6A.

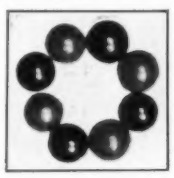


FIG. 8D (VI.)—Moderately stable; tends to form Fig. 8B.

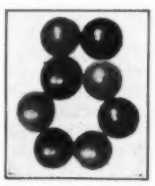


FIG. 8E (V.)—Rather unstable; tends to form either Fig. 8D or Fig. 8B.

FIG. 8F (V.)—Moderately stable.

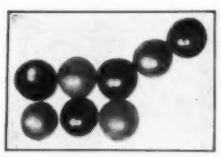


FIG. 8G (V.)—Not very stable; tends to form Fig. 8B, or more weakly, Fig. 8K.

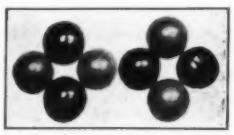


FIG. 8H (IV.)—Unstable; tends to form Fig. 8B.

FIG. 8J (V.)—Fairly stable; tends to form Fig. 8B.

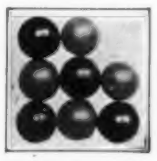


FIG. 8K (V.)—Fairly stable; on agitation of water passes into Fig. 8E.

either a positive or negative charge, and it is to these that chemical activity is due. It is the possession of these charges which also makes matter amenable to electric influence, to electro-chemical decomposition, and the like. Some atoms possess only a single unit of charge; others possess a couple of units, which may or may not be of the same sign; others again possess three, some four, and so on as high as six; it appears to be doubtful whether any atom possesses more than this number of units of charge in the unneutralized or active condition.

It may be said, How can an atom possess two opposite charges without their neutralizing each other? The answer is very easy: the charges may be located at opposite ends of a diameter, just as the earth has a north and a south magnetic pole. So also four or six charges, whether of the same or of opposite sign, can

FIG. 8L (VI.)—Moderately stable. When it does fall together forms Fig. 8A.

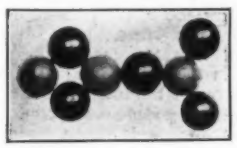


FIG. 8M (VI.)—Stable. On agitating the water breaks up into 4A and 4C, which recombine to again form Fig. 8M. Sometimes splits up into 5A and 3, which will combine again to form Fig. 8M.

FIG. 8N (IV.)—Unstable; tends to form into Fig. 8C.

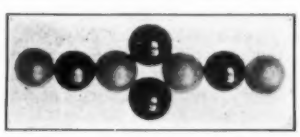


FIG. 8O (IV.)—Rather more stable than Fig. 8N; tends to form Fig. 8B.

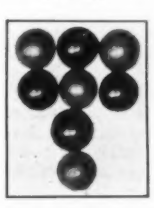


FIG. 8P (IV.)—Rather unstable; tends to form Fig. 8K.

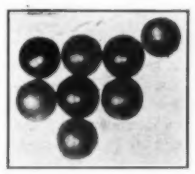


FIG. 8Q (IV.)—Rather unstable; tends to form Fig. 8A.

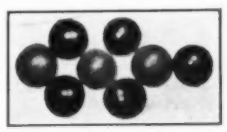


FIG. 8R (IV.)—Rather unstable; tends to form Fig. 8A.

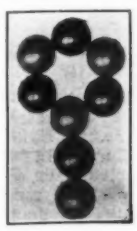


FIG. 8S (IV.)—Rather unstable; tends to form Fig. 8E.

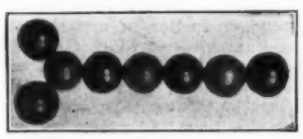


FIG. 8T (III.)—Moderately stable; tends to form Fig. 8L.

be easily supposed dotted about in regular grouping on or near the surface of an atom. For an atom is not an infinitesimal thing; it is small, but it has a definite size; and by its surface is meant the boundary of its immediate sphere of activity—the range into which no other atom can be squeezed without extraordinary violence—the range within which cohesion acts in full vigor. Within this sphere of activity the atom resides, with all its parts, and with any free charges which may belong to it. It appears to be a complete micro-cosmos in itself, full of movement and energy and activity, not at all the small, hard lump which some perhaps once supposed it to be.

This being so, how are we to conceive of the aggregation of atoms into compound molecules? If a positively charged atom and an equal negatively charged atom approach one another, they may obviously be expected to combine. Suppose they do; have they, thereby, neutralized each other's activity, and lost all attracting force for other charges in their neighborhood? Or does the satisfaction of their main attraction leave still a residual affinity which can exert an effect on other atoms which happen to approach too near? The answer is quite simple and can be given either by theory or by experiment. It is perfectly certain that residual affinity must exist, that a given charge is by no means completely satiated by a single opposite equal charge, but that it may take on at least three, possibly four, equal charges before it declines to receive any addition.

Experiments can most easily be made on models of

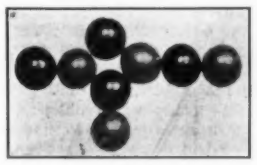


FIG. 8U (III.)—Very unstable; tends to form Fig. 8B.

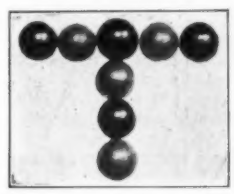


FIG. 8V (II.)—Very unstable; tends to form Fig. 8B.

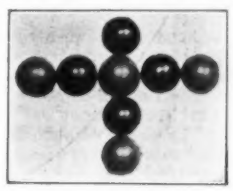


FIG. 8W (II.)

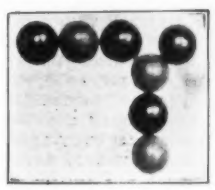


FIG. 8X (II.)

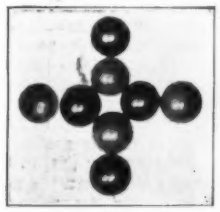


FIG. 8Y (I.)

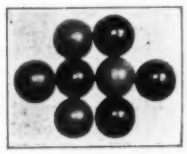


FIG. 8Z (II.)

Figs. 8W to 8Z represent patterns that are very unstable; care is necessary to form them.

atoms, free to move only in one plane; and thus it is found that not more than three of one sign can group themselves round another of opposite sign, and that if a fourth is brought up, one of the three immediately goes away. But to this system, with one positive surrounded by three negatives, another positive may cling with ease; and after that some more negative can also be taken on, and so gradually a great number of regular and complex patterns can be built, even out of floating models, each with one attracting center only. The easiest way to try the experiment is to utilize the attracting force of magnetic poles, which obey the same inverse-square law of distance as electric charges. By inclosing a number of long, thin magnets in vertical floats like hydrometers, it is possible to arrange so that their similar or opposite poles shall come near each other, the upper ones acting on each other near the surface of water, and the lower ones also acting on each other at a different depth, the upper and lower strata being fairly independent of each other by reason of distance and inefficient angle. Fig. 0 shows one of these floating magnetic bulbs. In order to avoid

capillary disturbance and to secure free motion, it is desirable that the part above the water shall be small, and that any protruding bulbous portion which is to come into contact with similar things shall be entirely submerged.

This being arranged, it is easy to study the groupings and make drawings of them—and this is done in the diagrams which follow—for a moderate number of such floats.

Copies of the drawings are appended, with notes expressive of the results of observations made on the instability of the various configurations; that is to say, their liability to break up or to change into other forms when subjected to irregular disturbances, such as may be produced by agitating the water in which they are floating. Positive and negative charges are distinguished by differences of shading.

It will be observed that the figures are numbered in accordance with the number of floats which go to form each pattern, and that after each number is a letter to distinguish between the different patterns each number of floats can give. The lettering is approximately and roughly in the order of stability; but to give a rather better estimate, a "mark" is awarded, in small Roman characters, representing the average of independent estimates of the stability of each group; X. meaning the most stable grouping possible, and I. or II. meaning that the group can just be formed with a little care, but that the least disturbance breaks it up.

Notes accompanying the diagrams give further details. They are all based on simple experimental observation.

It is a striking fact how many varieties of grouping can be obtained from the number 8; and, of course, as soon as the number 12 is reached the variety of patterns will be vastly greater.

Prime numbers are not likely to give anything like so many configurations as numbers possessing numerous factors.

So much for a system of attracting monads; but we can also make floats, each of which contain two vertical magnets, or three, or four; thereby imitating diads, triads, and tetrads. We may make all similar poles correspond, or we may make them alternately positive and negative; thereby getting a variety. It is quite clear that a chemical tetrad, such as carbon or silicon, is not a strongly electro-negative or electro-positive element; accordingly it is quite unlikely that all its four attracting poles or centers of force are of the same sign; it is quite likely that they are alternately of opposite sign. The earth, in fact, might be regarded as a tetrad if its two magnetic axes were much more widely separated than they are. It may be said that such a combination of poles would, after all, only give the resultant effect of two, in some intermediate position, and so, for distant effects, they would; but on particles which approach within close range their action is different—on them the attracting centers have a definite holding influence. When such tetrads come into contact with each other they can cling into elaborate groupings, such as are familiar in organic chemistry, and can at the same time have any amount of residual affinity for other outlying atoms, some of these affinities being fairly strong, and the resulting compounds stable, others being weak and the compounds easily decomposed; while some also are easily liable to fall over into allotropic modifications.

Meanwhile the study of residual affinity seems best conducted by observing the groupings caused by single attracting centers, inasmuch as these represent cohesive forces governed by the law of inverse square; and there are certain radiation phenomena which seem to indicate that molecules do, as a matter of fact, cling to each other in accordance with this law. Accordingly, what we observe in the groupings of the floating magnets may be akin to the molecular aggregates which are to be expected when the molecules of definite chemical compounds find themselves closely packed together, as in a liquid or solid—especially in the liquid state—which is well known to be far the most efficient for the purposes of chemical union.

Once more I must repeat that the configurations here depicted are due to single attracting centers. The experiments on diads, triads, and tetrads, though begun, are not yet nearly complete.

Every molecule must be thought of as throwing out lines of attraction or residual affinity into space, which fasten upon and draw together other groupings, sometimes building them up into more complex aggregates, sometimes disturbing their equilibrium and putting them into other shapes, sometimes itself getting pulled to pieces by the surrounding diverse attraction of numerous stable molecules; so that a single grouping in the midst of many others of a different kind may have its lines of affinity so diverted and distributed that its own family connections get broken up; in other words, it finds itself unable to exist alone in the crowd, and becomes ionized, a strong chemical affinity thus being reduced to impotence by the individually weak attractions of a great number of others, thus explaining the influence of mass on chemical action.

Moreover, molecules with their internal attractions thus weakened by the agency of a crowd of foreign molecules may, if they happen to meet, combine with each other more readily and powerfully than would have been possible under ordinary conditions; and indeed it appears that a new light can be thrown on many of the long-known facts of chemistry by this doctrine of residual chemical affinity, which for some time has been instinctively felt and preached by many chemists as a necessity, and can now be realized as having a clear and definite physical or electrical basis, and as opening a new chapter which requires to be worked out.

THE MANUFACTURE OF ARTIFICIAL MARBLE.

The production of artificial marbles constitutes an important branch of industry. Their employment is quite extensive, as covering slabs for the walls of stores and shops, halls, vestibules, and the wards in hospitals.

The operation is conducted by molding the constituent mixture, which is composed of 80 parts of plaster in powder, 20 parts pulverized marble, 20 parts sulphate of potash, with a 5 per cent solution of strong glue, mingled together with water.

A large glass plate, perfectly polished, measuring at most 2 meters in length by 1 meter in breadth, and about 20 millimeters thick, is placed horizontally on a metallic frame, fixed at a height which allows of looking at the glass from below. This glass is inclosed in a frame, which can be taken apart, having a height of 20 millimeters, and forming with the glass the mold into which the composition is poured. This is performed at one of the corners in such a way that the mixture shall spread quite evenly through the mold, taking care to prevent the formation of air bubbles within the paste. When the mass has reached a certain degree of hardness, hooks of galvanized iron wire, having the form of a reversed U, are sunk in at the back of it, to aid in the subsequent fitting of the slabs on the walls to be covered. As soon as the composition is perfectly hard, the mold is taken apart, and the slab detached. Previously, the mold has been lightly greased by means of a cloth that has been dipped in oil, in order to prevent the slab from adhering to the glass, and to facilitate its removal.

The different tints of marble are obtained by the employment of chemical products incorporated in the mass. For instance, is the yellowish tone of antique Greek marbles, which were originally white, desired? It is sufficient to dissolve ferric sulphate in the water with which the plaster is diluted; the chemical reactions are accomplished, and under the influence of the air impart to the marble a yellowish tone. The bluish coloration is obtained in the same way with cupric sulphate; the quantities of the metallic salts are always quite small. Artificial marble can also be treated by skillfully proportioning the colors, and thus secure the outward appearance of the natural marble, with the transition of shades, red and brown, blue, grayish blue, gray, grayish black, the most frequently employed.

The imitation of veined marble is readily obtained by the exercise of a little skill. If on a marble of yellowish or bluish color the appearance of dark yellow or blue veins is desired, they are drawn on the face of the slab with ferric sulphate or cupric sulphate in very dilute solution. A piece of sponge is preferably used for tracing these decorations. The gray veins on marble, tinted yellow by ferric sulphate, are readily formed by drawing them with a decoction of nutgalls. The spotting or marbling is obtained by light touches with a sponge soaked in a decoction of nutgalls, after a concentrated solution of sulphur has been added to the paste during its production. All the shades of marble can be imitated by the mixture in the paste of various chemical products, which, by their mutual reaction, produce the colors sought for.

But artificial marble can also be colored at the time of its manufacture in all its mass by the application of pulverulent substances rich in color. The colored powders are mixed in the dry state with corresponding quantities of plaster and shaken in granulating casks, to secure a uniform mixture. Ocher, blood-stone, manganese, wood charcoal, chrome yellow, and cinnabar green are made use of. Mica, ground in order to produce a crystalline appearance, is employed for certain kinds of marble. The small veins are the result of the incorporation in the mass of small crystals of pyrites or fragments of the alloy proceeding from the manufacture of bronze powders.

The slabs of marble are polished dry by rubbing the outside face energetically, after an application of talc by means of a soft woolen cloth.—Translated from La Revue des Produits Chemiques.

THE PRODUCTION OF ABRASIVE MATERIALS IN 1904.

"From year to year there is a noticeable variation in the quantity of the different kinds of abrasives produced," says Dr. Joseph Hyde Pratt, of the United States Geological Survey, in his recent report on the production of abrasive materials in the United States. This is due partly to the repeated replacement of a certain abrasive either by another natural product or by an artificial abrasive. In 1904 the noticeable changes are the decrease in the total value of the production of natural abrasives and the very large increase in the production of artificial abrasives. The only natural abrasives in which there was an increase of production in 1904 over previous years are grindstones, pulpstones, and pumice. Usually where there is a decrease in the domestic production there is an increase in the imports, but the imports were less in 1904 than in 1903. The large increase, however, in the production of artificial abrasives makes the total value of the consumption of abrasive materials greater in 1904 than in any previous year; and thus, in the aggregate, there is a gradual increase in the quantity of abrasive materials utilized each year in the United States, which is the natural outcome of the continuous growth of our manufacturing industries.

There are many kinds of abrasive materials on the market, some of which are natural products and others artificial. These are divided by Dr. Pratt into three groups:

(1) Those which occur as rock formations and are cut and manufactured directly into the form desired while retaining their original rock structure and appearance, as grindstones, scythestones, etc.

(2) Those which occur as constituents of either rocks or veins and have to be mechanically separated from the associated gangue and cleaned, as corundum, garnet, etc.

(3) Artificial abrasives, as carborundum, crushed steel, etc.

The abrasives included under these three heads and treated of in Dr. Pratt's report are oilstones and scythestones, grindstones and pulpstones, buhrstones and millstones, pumice, infusorial earth and tripoli, crystalline quartz, garnet, corundum and emery, feldspar, carborundum, crushed steel, artificial corundum (alundum) and adamite.

In 1904 the aggregate value of the production of the natural abrasive materials was $1,406,851, which is a decrease of $86,452 as compared with $1,493,303, the value of the 1903 production. The value of oilstones and scythestones was $188,985, of grindstones and pulpstones $881,527, of buhrstones and millstones $37,338, of pumice $5,421, of infusorial earth and tripoli $44,164, of crystalline quartz $74,600, of garnet $117,581, of corundum and emery $57,235.

To the value of the natural abrasives should be added the value of the artificial abrasives, which in 1904 was estimated at $830,926, an increase of $337,111 as compared with the estimated value of $493,815 of the 1903 production. The amount of carborundum produced in the United States during 1904 was 7,060,380 pounds, of crushed steel 790,000 pounds, of alundum 4,020,000.

The total value of the abrasives used in the United States is still further increased by importation. In 1904 the total value of the abrasives imported was $547,804, as compared with $621,575 in 1903, a decrease of $73,771. This brings the total value of the abrasive materials consumed in the United States during 1904 to $2,785,581, which is $176,888 more than the value, $2,608,693, of the 1903 consumption.

The abrasives produced in 1904 came from 26 different States, which are enumerated in the order of the values of their respective productions: (1) Ohio produced grindstones, pulpstones, oilstones, and scythestones; (2) New York, millstones, infusorial earth, crystalline quartz, garnet, and emery; (3) Michigan, grindstones; (4) Arkansas, oilstones; (5) New Hampshire, scythestones and infusorial earth; (6) Wisconsin, crystalline quartz; (7) Missouri, grindstones and infusorial earth; (8) Massachusetts, infusorial earth and emery; (9) Pennsylvania, millstones, crystalline quartz, and garnet; (10) Connecticut, crystalline quartz; (11) Vermont, scythestones; (12) Indiana, oilstones; (13) North Carolina, millstones, garnet, and corundum; (14) Virginia, millstones and infusorial earth; (15) Maryland, infusorial earth; (16) Montana, grindstones and corundum; (17) Nebraska, pumice; (18) California, infusorial earth; (19) Florida, infusorial earth; (20) Kentucky, oilstones and crystalline quartz; (21) Kansas, emery; (22) South Dakota, pumice; (23) Wyoming, grindstones; (24) West Virginia, grindstones; (25) Georgia, infusorial earth; (26) Minnesota, feldspar.

TIME-RECORDING CAMERA.

To ascertain the exact speed at which motor cars are traveling is often a question of great importance to the general public who suffer by reckless motoring, and of equal importance to conscientious and careful motorists, who wish to obey whatever the law on the subject may be. A new time-recording camera has just been patented in England.

If the police wish to know the speed at which a motor car is traveling, two of the time-recording cameras referred to can be placed at each end of a "trap," the distance between the points where the cameras are located having been accurately measured. The plan is for the cameras to take actual photographs of a car, including the people on the car, as it passes the selected spots, recording the time of taking to the fraction of a second. This gives the speed and means of identification of car and occupants. If the watch be synchronized, the decision arrived at must be accepted by all parties as accurate. It is proposed, the Motorcar Journal states, that when a driver is summoned for exceeding the speed limit he be furnished with the photographs of the car entering and leaving the "trap" and the time records, and be given an opportunity before appearing in court to measure the length of the trap and calculate from this data the time actually taken in traversing the distance and from this the rate of speed. The Motorcar Journal's description in part is as follows:

With this camera it is possible to take a photograph of any rapidly moving object passing any given point, the shutter speeds giving a range of exposures from one twenty-fifth of a second to one one-thousandth of a second; at the same time and with the same movement a photograph is taken of a watch, thus giving the exact time. A special case is provided for the watch, and in an opening above the latter a card is inserted giving the date, which can be signed by the officer responsible for the time test. Underneath the dial is a numbering apparatus, and each watch case bears a registered number before it is sold. The case is so made that after the official has placed the watch in the case it can be sealed (not locked) up, and it is impossible for the person in charge of the same to tamper with the watch without breaking and destroying the seal. The camera thus makes a record that can be produced in court, and if carefully stored can be referred to and reproduced months afterward.

ENGINEERING NOTES.

There is, probably, for painting girder work nothing to beat good red lead as a protective coating; but there is considerable difficulty in getting it reasonably pure, without which quality its usefulness will be greatly reduced. The question of purity will, however, be found to be largely a question of price. It may be stated broadly that, whether for steel or for iron, the first protective covering is, perhaps, the most important of any it will ever receive.

When coal in the ordinary form is used as a fuel, smoke abatement involves some means of varying the coal supply and the air supply according to the demands made upon the boiler. When ordinary hand firing is resorted to, the great irregularity of the coal supply will cause poor combustion and smoke unless the air supply is varied to correspond. Steam jets are frequently employed under these circumstances, and, if properly put in, will improve the combustion by drawing in additional air over the grate and mixing it with the products of combustion in front of the bridge wall. The steam jet should be semi-automatic, the steam and air being turned on by the opening of the fire door and gradually closed off by a dash-pot attachment.

Just what benefit is to be derived from the use of laboratory apparatus is a question that must be answered, and in the answer will be found the method of instruction, based on that apparatus, conducive to the student's greatest good. It may be that this greatest benefit to the student can be obtained only with the greatest effort on the part of the instructing staff, which would be the case without apparatus, or it may be that through the medium of apparatus the professional instruction can be simplified and conducted by fewer and less able men than would otherwise be necessary. In reference to this relation of instruction and apparatus to the student, Prof. Armstrong has said: "What the colleges (American) are suffering from very largely is the great over-provision of appliances and under-provision of teachers and of well-prepared students. I think if they scrapped the greater part of the provision and obtained teachers who could develop more individuality in the students probably there would be a great improvement in the output." Naturally our first impulse on reading such an opinion is to deny the existence of the fault as Prof. Armstrong sees it, but there is in the statement the keynote of the whole situation: for he maintains that the aim of the instruction is to develop individuality in the student, denying only the efficacy of our means.

The use of steel in the construction of modern bridges, and the improvements made in its manufacture, thereby reducing its cost and increasing its reliability, have made it practicable to build structures of a magnitude never attempted before. Its introduction as a structural material had a marked influence on the progress and development of bridge building. Certain types of construction and details which have proved unsatisfactory have been discarded, and others which have undergone a process of purification and improvement have survived. Rational types of construction and details are now established, and have become the recognized standards for ordinary bridges of moderate spans. The present tendency is toward uniformity and to-day there is but little difference between the designs made by competent engineers. This tendency toward uniformity has also been extended to specifications for bridges and other steel structures, relating to quality of material, workmanship and unit strains. As late as five years ago, the requirements specified for the quality of steel were numerous, almost every railroad or bridge engineer requiring some different grade, and sometimes several different kinds in different parts of the same structure. Erratic specifications are now gradually disappearing, and engineers at the present time are nearly all agreed on the grade of steel best suited for structural work.

The development of large gas engines can be said not to date back further than five or six years. Eight to ten years ago they were initiated simultaneously in Germany, England, and Belgium, early attempts being made to utilize blast-furnace gas, which was expected to open up such a vast field for the employment of large engines. Although the first trials were only attempted on small engines, the results of the experiments soon gave encouragement to the efforts of the investigators. The Cockerill Company, of Belgium, constructed a single-acting Otto cycle engine of 200 horse-power, which has been working regularly at their establishment for six years. This stage in the path of progress was strongly accentuated by the 600-horse-power engine on the Delamarre-Debouteville system, which the Cockerill Company exhibited at the Universal Exhibition at Paris in 1900. This magnificent engine was single-acting, the piston having a diameter of 1.300 meters (4 feet 3 3-16 inches) and a stroke of 1.400 meters (4 feet 7⅛ inches). It was designed to develop its power at 80 revolutions per minute, which, with an initial explosive pressure of 310 to 325 pounds per square inch, produced on the piston a pressure of 300 tons at each explosion. In a short time several famous firms entered, in their turn, upon the construction of large engines intended to utilize the gases liberated by the various reactions occurring in the manufacture of iron, coke, etc., and the metallurgical industry was not long in entering upon the path of progress by replacing for its old boilers and engines powerful installations of explosion engines. It remained, however, to conquer the vast domain of manufacturing industry. It is in this sphere that the struggle is taking place with the steam engine, which a long career has endowed with improvements in methods and execution. The physical laws which govern the production and utilization of steam as a motive power have long been known, having at an early date emerged from the obscurity which enveloped their interpretation, and thermodynamic science has given them definite sanction by numerous investigations.

SCIENCE NOTES.

New industries are to be developed. This calls for special government recognition. The national Department of Agriculture aids such new enterprises by giving counsel and investigating the special technical difficulties; but is this kind of aid sufficient? If the government helps new manufacturing industries by giving them special privileges, why not aid new agricultural industries by bounties? If a bounty system were to become a recognized public policy (following perhaps the experience with sugar bounties), would it result in undesirable social and economic changes? The money grants to agriculture are only a fair offset to special privileges given to other industries.

Constitution of the N-Rays.—The investigations of M. Edmond Becquerel are considered as completing the hypothesis of his father, M. Jean Becquerel, relative to the constitution of the N-rays, according to which these rays are not constituted simply by an undulatory movement of the same nature as light. He is considered by French scientists to have established the fact that a pencil of N or N_1-rays traversing a magnetic field, of which the lines of force are perpendicular to the pencil, loses the property of acting on calcium sulphide. The β-rays emanating from radio-active bodies, whether the activity is intense like that of radium, or feeble like that of uranium, produce on calcium sulphide the same effects as the N-rays; and under the same conditions this action is arrested by the magnetic field. This conclusion is important, for it justifies the belief that in the N-rays the undulatory movement is accompanied with a radiation deviated by the field.

The need of evidence that lard is adulterated usually arises in prosecutions under a pure-food law, or in some other legal proceedings. The chemist must be able to say that the lard submitted to his inspection certainly has been adulterated—usually with cotton-seed oil—or his testimony leaves a doubt. A great number of tests for cotton-seed oil mixed with lard have been submitted, but practically without exception they have proven valueless. The two tests on which the chemist has chiefly based his decision as to the appearance of cotton-seed oil in lard are the Bechi reaction due to the reduction of silver nitrate and the Halphen test, a crimson color formed when the cotton-seed oil is heated with a little sulphur dissolved in carbon disulphid. But the reactions in these tests appear precisely the same in the pure lard made from hogs fed on cotton-seed meal and in lard adulterated with a small amount of cotton-seed oil; and in so far the tests are failures.

Employment of Vessels of Silica in Chemical Operations.—For some time vessels of quartz have been made, which are distinguished for their infusibility at the temperature of 1,500 deg. C., and their resistance to acids and to the action of sudden cooling. M. Berthelot has conducted experiments similar to those employed in the case of glass vessels, with which the temperature can scarcely be raised above 500 deg. He describes the operation suitable to employ, and shows that, contrary to what is produced in the case of glass, these vessels are not impermeable to steam and gases. The melted silica, solidified, behaves, up to a certain point, with reference to gases, like an animal membrane, susceptible of endosmose and exosmose. The cause of the phenomenon depends on the thickness of the wall, on its softening, on the adherence of carbon or other solid products in reaction, on the percentage of alkali united with the silica, on the succession of temperatures experienced and the duration of each of them, and, finally, on the constant opposition of the exterior air and the variations in the composition of the gases resulting from the gradual reactions of the oxygen on the combustible bodies, as hydrogen and carbon, that is to say, on the composition and variable tension of the interior gases.

Further chemical knowledge is needed dealing with the meaning of high pressures and of the accommodation of very high pressures in the fungi. As a rule, those protoplasts seem to be resistant to such high pressures which are also resistant to cold, desiccation, and other stimulation. Mayerburg, working under the instruction of Prof. Pfeffer, has recently applied himself to a study of the method by means of which the organism may regulate its turgor. It is evident that one of two propositions must be assumed, and that increased turgor may be produced either (1) by the penetration of substances from without, or (2) by substances of strong osmotic action produced within the cell through the stimulative action of external agents. It was determined in this case that in general no absorption of the substances bathing the plant occurs; therefore, osmotic substances are produced within the cell and largely by increased concentration of the normal organic cell products. The extent and method of this capability for turgor regulation are highly important, as is also the general question of the relation of turgor to growth. In recent times some of the important problems in this connection have been well suggested by the work of Ryssleberghe, Puriewitsch, Overton, Copeland, and Livingston.

In earlier days castor oil was best known as a medicine. The once universal disposition to regard it as a "sovereign remedy" is still among the early remembrances of living men. Not only was the customary maternal diagnosis of each childish ailment prone to result in a repulsive dose of castor oil, but even among hearty adults occasional self-prescribed doses of this so-called panacea were deemed necessary to the continuance of perfect health. Thus, two factors contributed to its consumption—its positive value as a medicine and its apparently harmless effect upon good health. In addition to its common use as a purgative, rheumatism, lumbago, skin affections, cramps, colds, and a host of other ills were popularly believed to yield to its curative properties; in fact, medicinal use was a highly important element in the castor-oil trade. Naturally, the marvelous advance that has been made in medical science in recent years has resulted in the widespread substitution for this once popular cure-all of less nauseating, if not more efficacious, drugs. As a general rule, physicians less frequently prescribe it. Modern preparation in capsules and compounds has, it is true, had a decided tendency to perpetuate its traditional uses as a self-prescribed remedy. In some rural communities, too, especially among the colored population of the South, its medicinal virtues still retain much of their old-time popularity, and in some pharmaceutical compounds it is still a staple. In short, considerable quantities of the high grade of castor oil are still absorbed by the drug trade, although its value as a medicine has, on the whole, somewhat declined in public esteem, and there no longer exists for it so universal a demand as a "home remedy."

TRADE NOTES AND RECIPES.

Polishing Powder for Mirrors and Panes.—Crush to powder Cologne chalk 60 grammes, tripoli 30 grammes, bole 15 grammes. For use moisten the glass a little, dip a linen rag into the powder and rub the glass until it is clean.—Maler Zeitung.

To Remove Water Stains from Varnished Furniture.—Pour olive oil in a dish and scrape a little white wax into it. This mixture should be heated until the wax melts and rubbed sparingly on the stains. Finally, rub the surface with a linen rag until it is restored to brilliancy.—Maler Zeitung.

Milk as a Preserve.—Engineer Budde, of Copenhagen, has discovered a preserving agent for milk, which consists in adding to the milk, which should be as fresh as possible, enough hydrogen peroxide to cause it to be completely decomposed by the enzymes of the milk. For this purpose 1.3 per cent. by volume, of a 3 per cent hydrogen peroxide solution is required. The milk is well shaken and kept for five hours at 50 to 52 deg. C. in well-closed vessels. Upon cooling, it it said to keep fresh for about a month and also retain its natural fresh taste. With this process, if pure milk is used, the ordinary disease germs, it is claimed, are killed off soon after milking and the milk sterilized. For still longer conservation, Budde adds another harmless preserving agent which he keeps secret, as it has not yet been patented.—Neueste Erfindungen und Erfahrungen.

Bleaching Soda.—Henckel's bleaching soda, a washing agent to obtain dazzling white laundry, consists of water glass (soluble glass) mixed with soda and containing a few per cent of tallow soap and powdered starch.

Following are some recipes for the preparation of this kind of bleaching powder:

Heat soluble soda glass, 5,000, and mix intimately with calcined soda, 2,000.

The resulting hard mass is broken up in a pounding machine.

Or mix:

1.	Soluble soda glass	2,500
	Calcined soda	3,500
	Powdered borax	300
	Powdered soap	400
	Potato starch	300

Or:

2.	Powdered soda crystals	8,000
	Powdered water glass	2,000

—Neueste Erfindungen und Erfahrungen.

To Expel Poisonous Gases from Wells, etc.—Well-diggers do not seem to be sufficiently acquainted with three simple methods of expelling gases from wells, etc. The first consists in pouring as much hot water as possible along the walls of the well. The ascending steam will carry along the pernicious gases, thus clearing the hole of foul gases in a short time sufficiently for a man to be able to be lowered by means of a rope. When no hot water is at hand, a second method may be employed, which, being very simple, is commendable for various other purposes. An open umbrella attached to a strong string and with the point downward, is lowered into the well; by pulling it up rapidly several times by means of the string the well may be dried. Many wells, however, are blocked up by the pump-posts and their supports so that an open umbrella cannot be lowered. In that case, there remains, outside of the hot water, only the fire hose. The latter, as is well known, can also be used as an air-pump. All that is necessary is to lead the hose to the bottom of the well, and to supply the victim of an accident with fresh air till a rescuer can venture down. A very simple and yet effective remedy is the third: Before going down into the shaft, place a windlass with a thin wire rope over it from which a burning well-sinker's or miner's lamp should be suspended and slowly allowed to descend into the shaft. If there is a sufficient amount of foul gases in the well the lamp will go out. This affords one a knowledge of the height

of the gases. Then the rope is pulled up and a tin pail as used by the tinsmith for soldering is attached to it; this pail is filled with pieces of wood which are then ignited. The pail with the burning wood is repeatedly lowered into the shaft until a permanent fire indicates the purification of the air.—Der Gastechniker.

ELECTRICAL NOTES.

According to the view of H. Le Chatelier, the increase of the electric resistance is proportionate to the number of atoms present of any element which is contained in the steel in solid solution. This theory has, of late, been more exactly formulated by C. Benedicks, who has also given a formula for calculating the electric resistance. This formula has been tested, and the agreement between the figures observed and those calculated may be considered very close.

The cable steamer "Stephan," of the North German Sea Cable Works, is about to commence loading the main section of the Shanghai-Yap cable of 3,600 kilometers length, the manufacture of which has been accelerated by the above company, so as to enable the new cable to be taken into service by the end of this year in the interests of the German-Dutch Telegraphic Company, whereas it had been intended at the beginning not to commence operations before the end of April of next year.

The problem of the installation of electric long-distance railways has been recently discussed by the German daily press. In opposition to rumors lately prevalent at the exchanges, the various projects suggested by the principal electric companies seem to progress but slowly, owing to the bearing of any decision to be taken by the State, the cities concerned, and the companies themselves. Only in the electrification of the Hamburg-Altona branch railway are there any visible advances to be noted, it being stated that in the immediate future contracts will be granted to the Allgemeine Elektrizitäts Gesselschaft for the motive equipment of the cars and for part of the conductors, while the Siemens-Schuckert works will be intrusted with building the central stations and supplying the larger part of the conductors and part of the equipment of the cars; any lighting plants as well as any other outfit will finally be supplied by the Lahmeyer concern, while the State railways themselves will provide for the permanent way, rails and cars. As to the three "city railway" schemes, the Allgemeine Elektrizitäts Gesellschaft and Siemens-Schuckert works have agreed to deal with these on a common basis. The Cologne-Düsseldorf railway project (35 to 40 kilometers, 21,000,000 marks) seems to be the farthest advanced. By far the largest of the projects in question, viz., the Berlin-Hamburg high-speed railway (cost about 250 million marks) is at the present moment being revised according to principles of a technical character suggested by the minister. At any rate, the Allgemeine Elektrizitäts Gesellschaft has been intrusted already with constructing an experimental train to be used for trials on the Spindlersfelde line. On the other hand the railway department is credited with projects of an ellipsoidal experimental railway in the north of Berlin, where an experimental data as to the wear and tear of the stock are to be collected. As to a forthcoming electrification of the Berlin Metropolitan Railway, this would not seem to be contemplated before the Hamburg-Altona electric railway has been opened and worked satisfactorily.

The government of Peru has decided on installing wireless telegraphy stations in the forests of the country with a view to provide for a telegraphic connection between the capital, Lima, and Iquitos, which is the main harbor on the Amazon River. Any other means of communication would be quite out of the question in the present case, owing to the inaccessibility of the wild forests and the superstitious dread of electric wires shown by the Indians, who live in a most primitive and savage condition. Overhead wires could therefore not be installed nor could cables be laid through the river beds, owing to the rapid character of the streams. The government accordingly intrusted last year an engineer of the Gesellschaft für Drahtlose Telegraphie of Berlin with investigating the problem. This gentleman started for the interior of the country accompanied by forty workmen and numerous Indians for transporting the most indispensable tools and food, to select places for the five stations. This expedition had to contend with enormous difficulties, being cut off from any connection with the civilized world in deserts which so far had not been visited by any European and being exposed both to the severity of the climate and the enmity of the natives. This expedition which was carried through with exceptional energy resulted, however, in contracts being granted by the government of Peru to the above-named German company giving the latter a monopoly for the exploitation of wireless telegraphy in the country. Two engineers and one mechanic therefore once more set out quite recently for the interior to construct the first wireless telegraphy station. Telegraphic connection having so far existed between Lima and Puerto-Bermudez beyond the Cordilleras, the latter was chosen as starting point of the wireless telegraph service. Between Bermudez and Iquitos there is a distance of 1,000 kilometers which will be bridged over by three intermediary wireless stations. Wireless connection is, however, eventually to be extended from Iquitos to Manaos on the Amazon River and thence as far as Para on the Atlantic Ocean, so that a connection between the latter and the Pacific Ocean would be completed.

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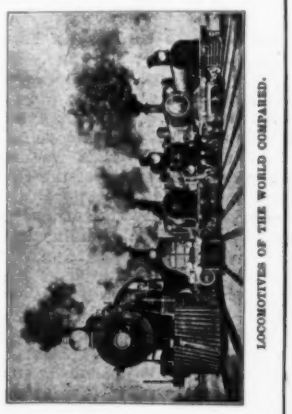

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